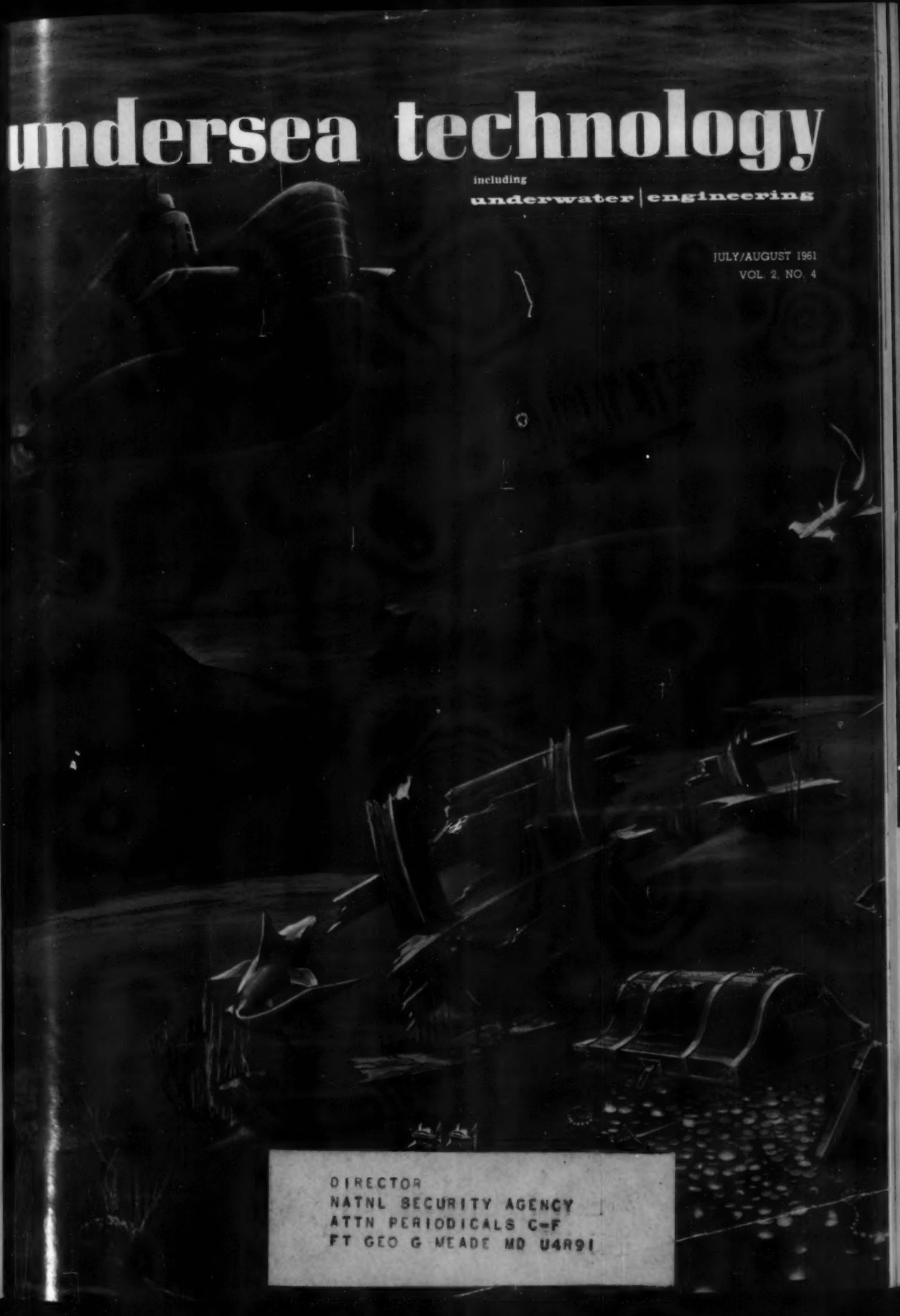
undersea technology

including

underwater | engineering

JULY/AUGUST 1961
VOL. 2, NO. 4



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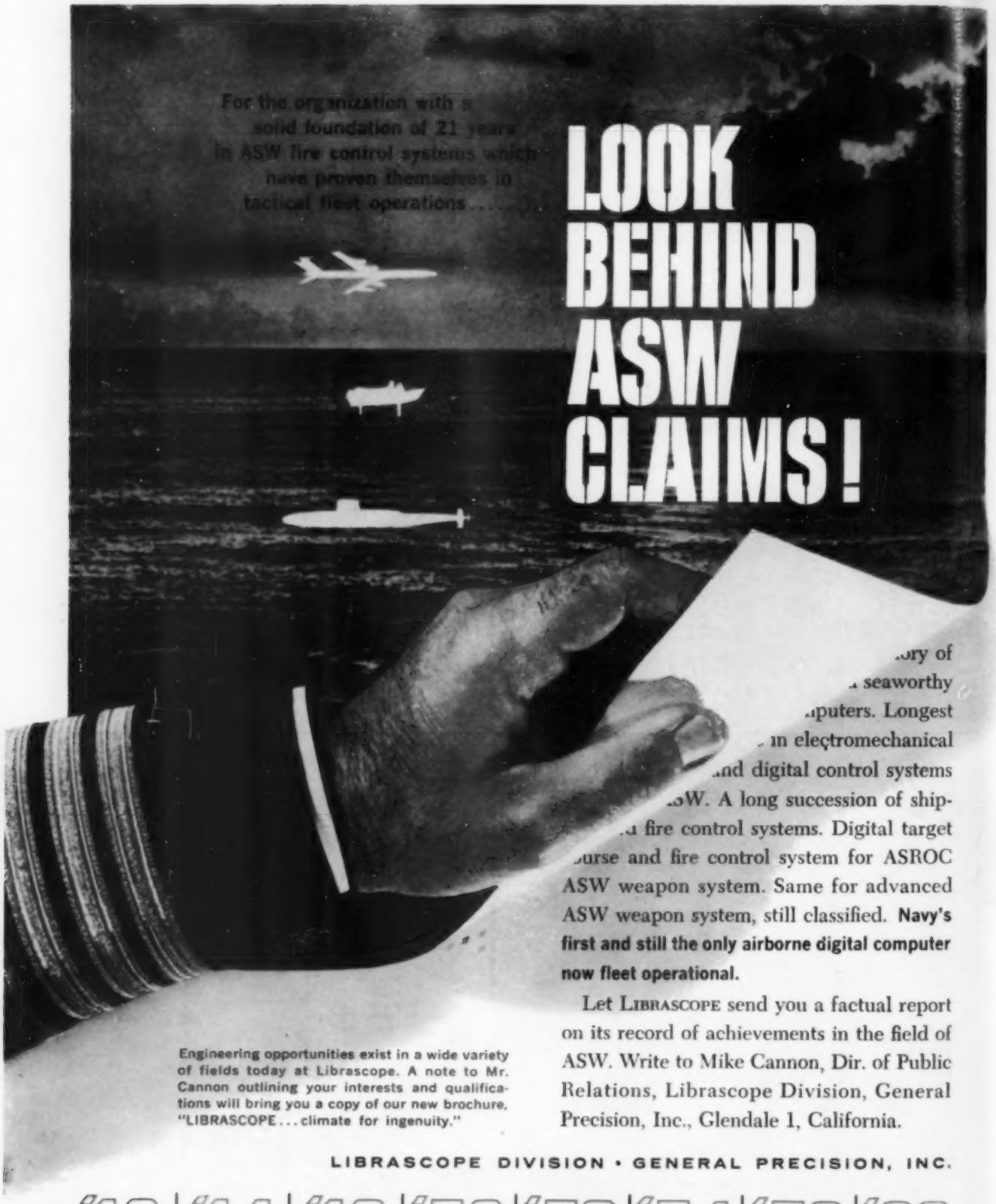
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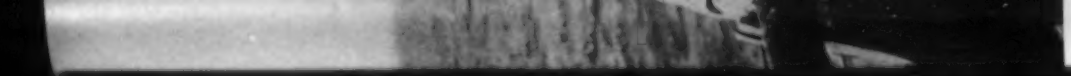

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undersea technology

COVER: The cover picture of this issue originally appeared as an illustration in **VANTAGE**, an internal publication of the Defense Systems Department, Defense Electronics Division, of General Electric.

The artist, Hams Otten, of GE was given the assignment of symbolizing the vast treasure of innerspace. The entire undersea technology industry is challenged to tap the resources of this rich, yet largely unknown, realm.

Vol. 2 Number 4
July/August 1961

EDITORIAL

SECURITY—THE MESS AROUND US 6

NEWS

UST SOUNDINGS 12

SPECIAL REPORTS

UST NEEDS IN REVIEW A look at the needs for new and improved Naval engineering technologies, concepts, systems, and hardware 15

POLARIS—TODAY AND TOMORROW Brief summary of some of the problems the Fleet Ballistic Missile submarine may face in the future with the advancement of science 20

FEATURES

UDT—A HUMAN WEAPON Picture coverage of indispensable undersea manpower. Navy looks for more sophisticated subsurface equipment 17

PLASTIC PRESSURE HULLS Article points out advantages of plastic sandwich construction concept for deep-depth pressure hulls. 18

SPECIAL PUMP FOR HYDRAULIC TEST Description of a unique and versatile hydraulic testing device in use at the Naval Air Materials Center 21

ACOUSTICAL DOPPLER Report shows how Doppler is used in signal analysis and discrimination 22

COLUMNS

UNDERCURRENTS ..... 8 *CAPITAL REPORT* 10

HEEL & TOE WATCH 33

DEPARTMENTS

NEW PRODUCTS ..... 27 *LITERATURE* 30

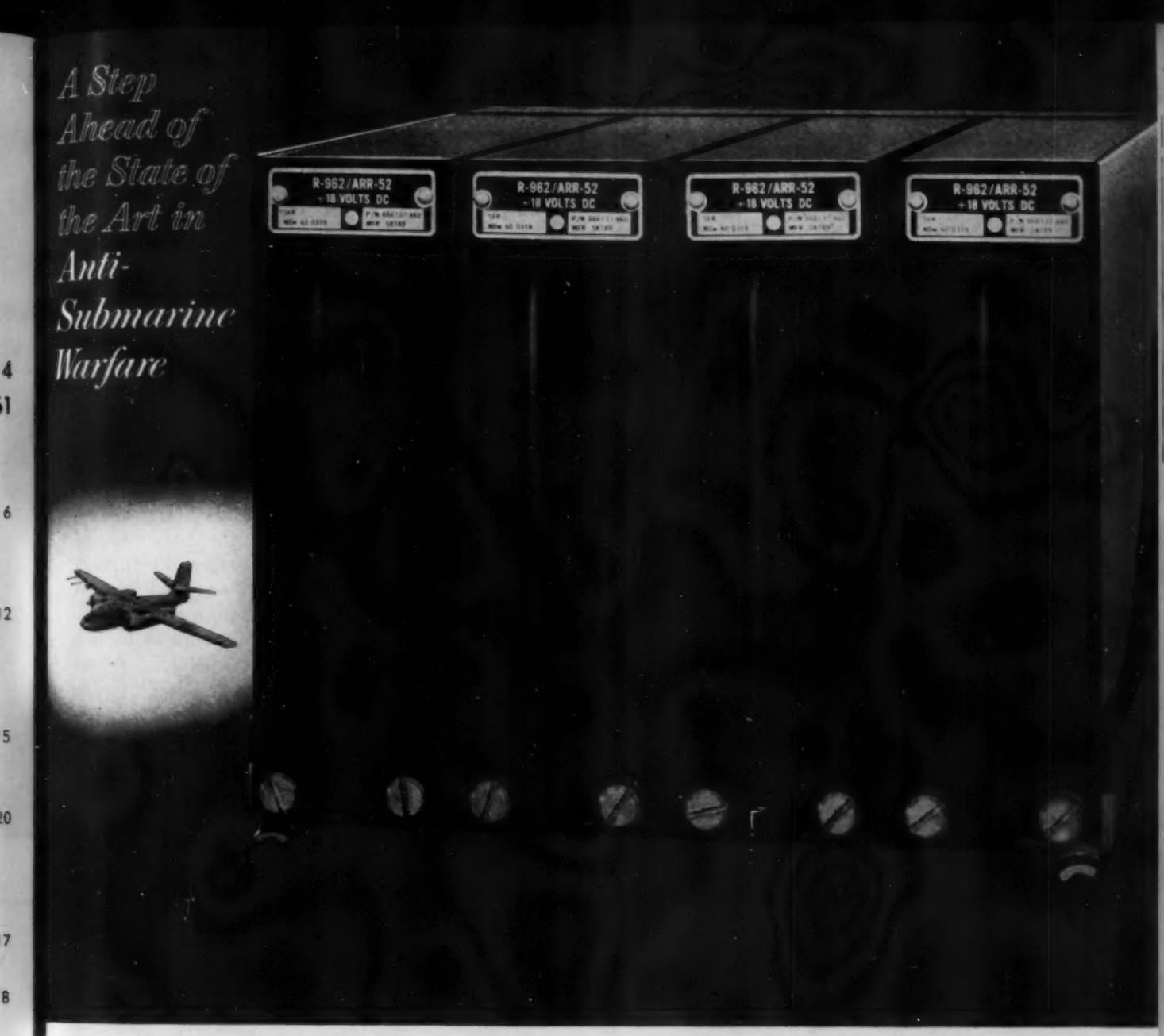
PEOPLE/EMPLOYMENT ..... 31 *LETTERS* 32

ADVERTISERS INDEX 34

PICTURE CREDITS

p 17, U. S. Navy; p. 21, Denison Engineering Div., American Brake Shoe Co.

A Step Ahead of the State of the Art in Anti-Submarine Warfare



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editorial

security . . . the mess around us

Security is a necessary evil—when it works. When it doesn't work, it's just evil. It smothers the creative engineering intellect of this country in the boundless red tape of bureaucratic procedures and the black cloak of ignorance.

We are talking about the present government system of classifying information. This is an old saw that's been played many times. We bring it up again solely because, though overworked in print and voice, it is still a mess. Our security system—the way it now works—enables Russia to enjoy a constant and current flow of information on our defense programs and technologies, but it plays hell with American industry's efforts to do as much.

The classification mess grew like topsy and thrives like an amoeba—growing, growing, growing. No particular administration can be blamed for letting it get out of hand and none, so far, can take any credit for ameliorating the situation.

It has become a regular ritual that each new Secretary of Defense brings with him a new information specialist, following which a period of more intense idiocy seems to overtake the five-sided puzzle palace—as note one recent directive stating that just because an item has been cleared once for publication does not mean that it will necessarily be cleared a second time!

One of these days perhaps a man will assume this position who not only has some idea of the problem, pro's, and con's of military classification, but who will also do something constructive about it. Just what, we can't predict, but as a starter we'd suggest:

Cut the size of the classified package. Make it small enough so that it can be effectively secured, so that vital leaks can be traced readily to their source.

Stamp dates on each document by which time the classification automatically downgrades or simply becomes inoperative—barring positive action to renew the classification. This has been started but procedure should be more widely and rapidly applied.

Break DOD security classification into two distinct areas to operate under different rules and philosophies . . .

. . . 1) military plans and hardware performance: This data to be held in strictest security until such time as the plans are so far along in execution and the hardware in such wide field service use as to make further classification useless.

. . . 2) technological developments: These should seldom be classified (except as to specific application) unless it is a truly major breakthrough with a direct and vital bearing on a specific piece of hardware. Modern military superiority depends in very large measure on technological superiority *in the field*—not just in locked file cabinets. And, the advance of science and engineering is directly proportional to the free flow and exchange of information and ideas. The more demanding the field of endeavor, the more this is true.

"Need to know" should be severely enforced in the case of military plans, weapon performance, etc. It should be virtually eliminated in the case of technological developments, for how does a project engineer with a problem know where he will find the solution until after he has found it? Too often a development in a completely unrelated field provides the answer.

Penalties should be as severe for over-zealous use of the classification stamp as for careless talk. Now, it's easier and "safer" to classify.

Point is: So much is classified today that nothing is secure. The more information released to industry, the better the job industry can do. Also, however, the more information released, the easier Russia's job is made. Between these two points is sound middle ground. Somebody should determine what this is, for we're a long way from it now, and it's hurting us.

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undercurrents

By Peer Fossen

Undersea technology firms with interest and capabilities needed to help solve this nation's oceanographic problems will have an opportunity, during the week of August 14, to become better acquainted with what these problems amount to and what course should be taken to solve them. The conference—first of its kind—will be held under the sponsorship of the newly formed Interagency Committee for Oceanography, chaired by the Hon. James H. Wakelin, Jr., Assistant Secretary of the Navy (Research and Development). Participating Agencies are: Atomic Energy Commission; National Science Foundation; Dept. of Health, Education and Welfare; Dept. of Defense (Army Beach Erosion Board, Air Force Terrestrial Labs., Office of Naval Research, Navy Hydrographic Office, Navy Labs.); Dept. of Interior (Geological Survey and Bureaus of Sport Fisheries, Commercial Fisheries, and Mines); Dept. of Commerce (Weather Bureau and Coast and Geodetic Survey); Dept. of the Treasury (Coast Guard).

Objective of the National Oceanographic Program to be carried out by the Interagency Committee is: "To acquire the understanding of the ocean and to translate this understanding into operational concepts and hardware which will enable the United States and its allies to exploit our peculiarly oceanic position militarily . . . economically . . . and politically." Of immediate interest is the collection of all available oceanographic data and to have same turned over to the Oceanographc Data Center for reduction and coordination. The Data Center has been in operation at the Naval Weapons Plant since January 1961.

The August conference—to be held in Washington, D. C.—will, among other things, deal with getting sensors and establishing methods for most efficient collection and turn-over of data to the Center. It is hoped that work with the data will gain interest on a large-scale, nation-wide basis, and that the first hardware and operational concepts resulting from the data and follow-on research—pure as well as applied—will be available for two new oceanographic vessels expected to go into operation in mid-Fiscal Year 1963.

* * *

Hon. George P. Miller, Calif., chairman of the House of Representatives Subcommittee on Oceanography of the Committee on Merchant Marine and Fisheries, has submitted a bill to the House proposing that the name of Navy Hydrographic Office be changed to Navy Oceanographic Office and that the Hydrographer of the Navy be known as the Oceanographer of the Navy. The Hydrographic Office plays a very important role in the National Oceanographic Program discussed above. For example, the Oceanographic Data Center is under Hydrographic Office Administration.

* * *

Navy's ONR and prime contractor Hudson Labs. of Columbia University have attached tight security measures to Project ARTEMIS. Aside from what was offered in terms of information when the story broke some time ago, nobody is talking. All research organizations and hardware suppliers have standing orders to avoid any discussion of the project, for which about $6.8 million was spent in FY '61, and which is the largest known effort in long-range sonar detection. The project, rated a high-priority requirement by Navy, whose toughest undersea problem remains surveillance, is part of Project TRIDENT, a large-area ocean surveillance research program which Navy hopes will lead to an operational underwater early warning system by 1966 or 1967.

In addition to Hudson Labs., these contractors are making or have made significant contribution to Project ARTEMIS: J. Ray McDermott, Inc.; Bendix-Pacific Div. of the Bendix Corp.; Harris Transducer Corp.; General Electric Co.; Hughes Aircraft Co.; IBM Federal Systems Div.; Edo Corp.; Space Technology Labs.; University of Michigan; PneumoDynamics Corp.; Massa Div. of Cohu Electronics; General Atronics Corp.; Simplex Wire and Cable Co.; Bell Telephone Labs.; Land Air, Inc.; Todd Shipyard; Avondale Marine Ways; Ling Electronics Div. of Ling-Temco Electronics; Welex Electronics Corp.; Marine Physical Lab. of University of Calif.; Woods Hole Oceanographic Institution; and Defense Systems Div., General Motors Corp.

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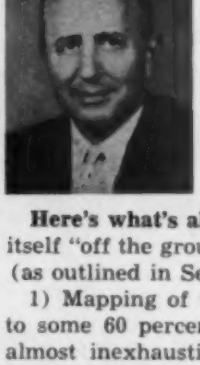


——capital report

By E. E. Halmos, Jr.

Here's what's ahead for undersea technologists, when the U.S. finally gets itself "off the ground" for a true all-out attack on problems of Oceanography (as outlined in Senate Bill 901) "to advance the marine scientists, etc.":

1) Mapping of the uncharted 98 percent of the ocean floor (as compared to some 60 percent of the moon's surface already mapped); 2) location of almost inexhaustible sources of all identified natural elements—including, for example, well over 400 billion barrels of oil; 3) developing more exact information on the "chain of life" which supports the vast fish populations, with the hope that production of fish for food, chemicals, drugs and other purposes can be vastly increased; 4) developing better knowledge of how to prevent further pollution of the seas; 5) development of submarine "highways" for commerce and defense; 6) eventual control of weather; 7) learning the geography of the sea for attack and defense; 8) vast improvements in accoustics and communications.

You can see just how badly the U.S. is doing in this area—and how much needs to be done, from these figures: The "world ocean" covers 71 percent of the earth's surface, and the U.S. has 12,255 miles of coastline—exceeded in length only by Canada and the Union of Soviet Socialist Republics. To explore this vast area, the U.S. Geological Survey has 15 ships in all—only one of them new, most of them 22 years or more old; the Coast Guard has six weather ships; private research organizations have six ocean-going research ships; the Bureau of Commercial Fisheries has 14 ships—ranging from 9 to 518 tons, the oldest of which is 35 years.

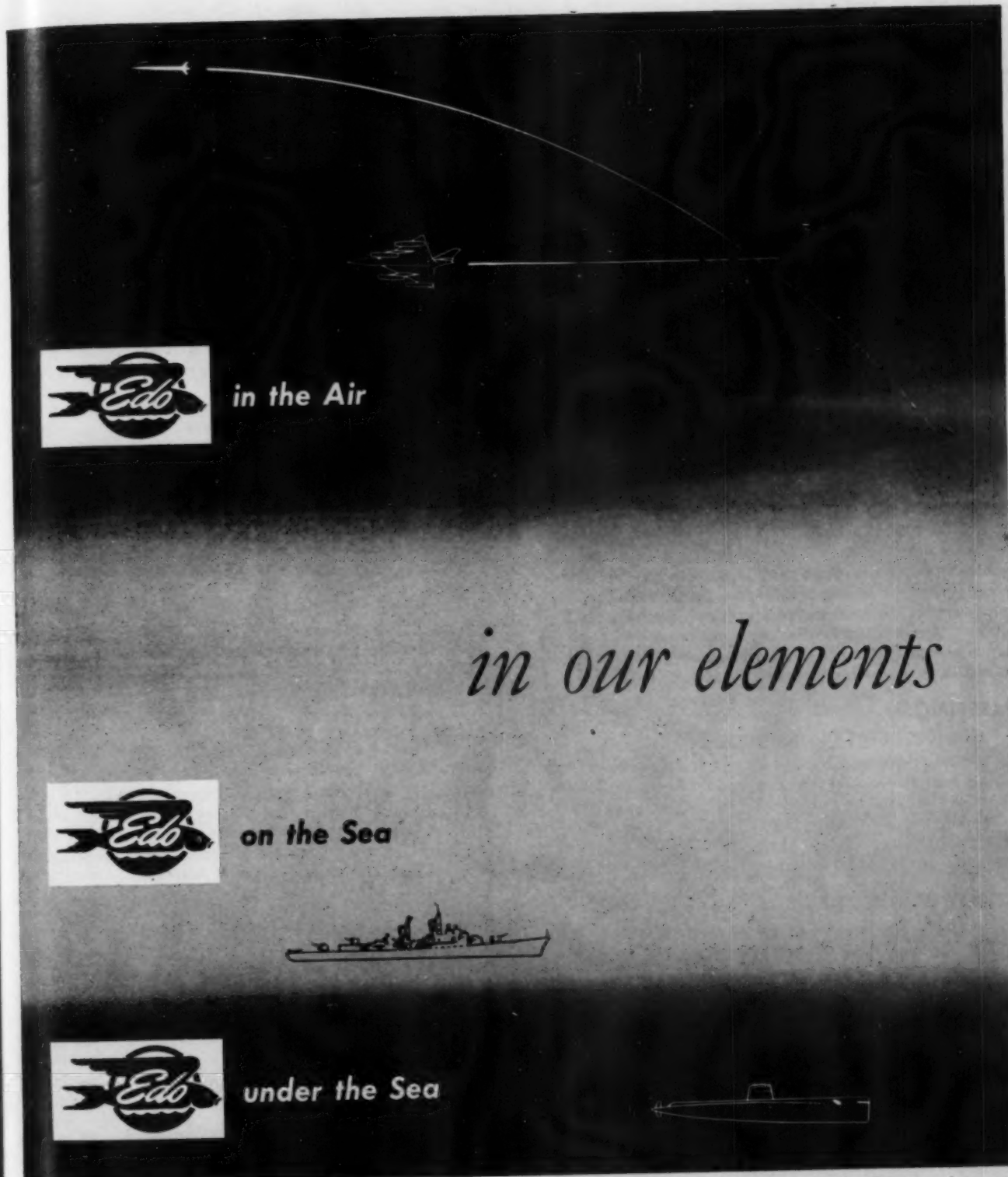
Contrast that with Russia, which, according to the Senate group, is operating more research ships than the entire free world—and operating them in all oceans. "Moreover", says the committee, "the Soviet scientific ships are larger, better equipped, have more laboratories and accommodate more marine scientists than those of any other nation. In the Bering Sea alone, Russia is operating 60 to 90 trawlers, 15 to 20 large refrigeration ships—all equipped for oceanographic survey work.

One important area of oceanographic research given little attention in previous studies is that of sound propogation—finding some means whereby a submarine commander may cruise in relative quiet, while at the same time being able to hear other vessels. A possible answer has been suggested by the existence of many layers of density in the sea: Idea is that it may be possible for a submarine to find a "layer" where its own sounds are muffled, but from which it can detect other noises.

Biggest area of potential improvement, however, is not in construction of ships or development of new devices. Instead, it is in increasing facilities for training engineers and oceanographers. In testimony before the Senate Committee, it was revealed that only six institutions of higher learning (U. of Washington, Oregon State; Johns Hopkins; Scripps Institute of Oceanography, U. of Southern California; Texas A&M and University of Miami) now give graduate degrees in Oceanography. And these graduate very few students each year—as few as five from Johns Hopkins—not because of lack of interest from students, but because of lack of facilities for their training.

The bill brought out by the Commerce Committee this year (S 901) is almost an exact duplicate of a bill okayed by the Senate in 1960 (S 2692) but which died in the closing rush of the 86th Congress. It calls for incorporation of the Navy's TENOC (Ten Years in Oceanography) program, and for a 10-year, $651.41 million expenditure which would include $276 million for new ships; 147 million for shore research and survey facilities; $100 million for development of new devices and instruments; $8 million for education and training of marine scientists.

It is interesting that another approach was attempted in the House: A bill (HR 4276) which would simply set up a "National Oceanographic Council" to coordinate research activities by some six federal departments already working in the field; set up national calibration and other standards, develop long-range plans, and make some loans to agencies engaged in exploration work.



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ust soundings

LATE NEWS

Boeing has been awarded a contract by Navy/BuShips for design and construction of a 15-ton, **twin hull hydrofoil test craft.** The 50-foot craft is expected to do 100 knots powered by a turbofan jet engine. . . . **A one-inch thick cable** is about to make a 10,000-foot journey into the earth beneath Greenland's icecap as part of a deep thermal core drilling project. The cable, designed and developed by U.S. Steel's American Steel and Wire Div., eliminates the drill pipe by providing power to an ice melting element at the tip of the heated core barrel. . . . **Under a 85-million contract** with the USAF, United States Underseas Cable Corp. is going to install a 700-mile extension to the existing underwater communications network serving the Atlantic Missile Range. . . . A newly-formed Litton Industries' **Geophysical Projects Office** plans to further expand R & D efforts in the field of oceanography. One area of specialization—ocean floor mapping. . . . . **Homing pigeons are under study** by ONR with a newly developed system developed by American Electronic Labs. Idea is—determine how pigeons fly home over unfamiliar terrain.

MEETINGS

"Reliable Information from Undersea to Outerspace" is the theme of the 16th annual ISA Instrument-Automation Conference being held Sept. 11-15, 1961 in Los Angeles. Association for Computing Machinery is holding their 16th national conference Sept. 5-8 also in Los Angeles. During the 4-day session 90 technical papers will be presented in 24 formal sessions.

ELECTRONICS

The ADDReSOR System (*A*nalog to *D*igital *D*ata *R*eduction *S*ystem for *O*ceanographic *R*esearch) is being supplied to the Woods Hole Oceanographic Institition by Tele-Dynamics Div/American Bosch Arma Corp. Primary usage will be automatic conversion of analog data gathered in the study of ocean waves, and investigations of thermal micro-structure in thermocline.

POWER

New seawater batteries from Yardney Electric Corp. are activated by flow of seawater through them. The silver-zinc Silvercel batteries provide as much as six times the power of ordinary batteries. Yardney has also developed a new method of automatic activation for their primary batteries. This system is currently part of the Lockheed-POLARIS project.

ASW

An extensive land-air-sea operation to determine the reliability of electronic devices used in the Navy's vital ASW defense program is being jointly undertaken by Brunswick Naval Air Station and Vocaline Company of America, Inc. Vocaline has implemented and is operating a complete electronic test facility consisting of monitoring station, laboratory and a 64-foot diesel-powered vessel provided by the Navy.

The world's fastest helicopter— the Sikorsky twin-turbine HSS-2—with a speed record of 192.9 mph, is scheduled to go into fleet service later this year. Ten HSS-2's have been flown to the Naval Air Station at Key West for the start of large scale training of pilots and ground crew in the Fleet Introduction Program (FIP).

R & D

"Ships of the Future" was the topic of an address made by RAdm. Ralph James, Chief,/BuShips, at the 59th annual convention of the Navy League. A very small BuShip group—devoted entirely to formulating "far-future" concepts—are investigating, among other things, submersible aircraft carriers, according to Adm. James. Future submarine design will depend largely on the results of experimentation with test vehicles ALBACORE (revolutionary hull form) and the AGSS (Experimental Deep Diving Submarine). Both subs are exploiting the limits of present technology, covering advanced weapons evaluation, acoustic and oceanographic research, higher speeds, noise reduction, dynamic stability, greater depths, increased maneuverability, etc., etc.

NEW TECHNOLOGIES

The first known underwater analysis of the ocean's radioactive sources have been made by the Navy Ordnance Lab with a new ultra-sensitive radiation measuring device called DUNC—Deep Underwater Nuclear Counting—sensitive enough to detect one atom of radium in a billion billion molecules of water!

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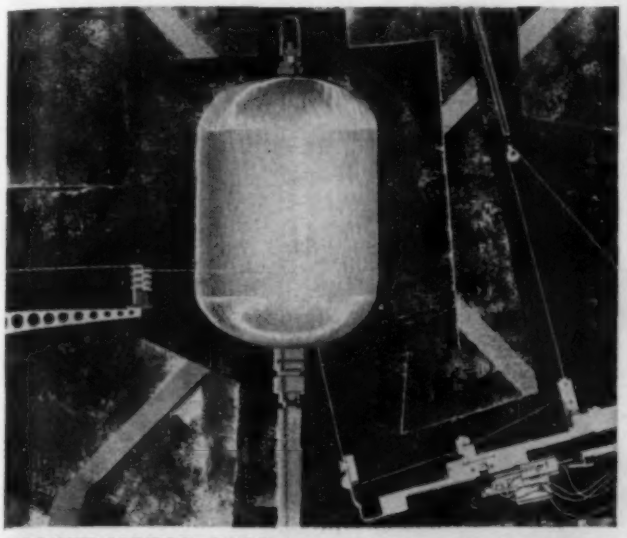

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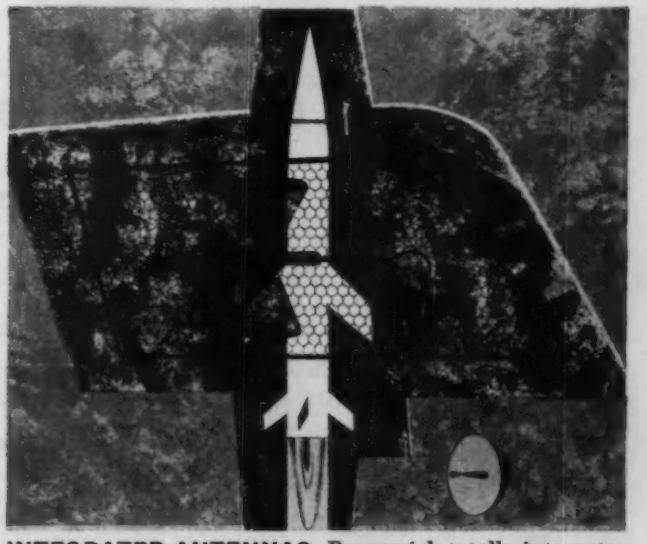

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undersea technology

Vol. 2, No. 4
July/August 1961

NEEDS IN REVIEW

By Don G. Groves

Success of tomorrow's naval missions hinges on a drastic revision of the naval engineering technology state-of-the-art. More and more companies are trying to get into the act, but to date very little has been achieved in terms of a unified approach to solve the problems at hand. This is especially true when it comes to the many diversified yet related problems and needs in the undersea realm. Many of these needs fall within security limits and cannot be discussed. However, several specific marine and naval problems are not affected by security and it seems in order to briefly list and discuss some of them since they concern every engineer in the U.S. industry.

The list is intended to be representative rather than all-inclusive of recognized (by Navy and segments of industry) problems illustrating the challenging and encompassing engineer in the U.S. industry.

For materials and equipments that must operate in the under-ocean, exposed to sea growth, corrosion, pitting erosion, galvanic action, high pressure, etc., there is a need to:

• Develop and improve high strength metals which are easily weldable, yet corrosion and pitting resistant; or develop economical coating or paint that will do same thing.

• Develop economical and effective materials and design techniques such as small-diameter, high-strength deep water mooring cables, underwater vehicles and robots, etc., for emplacement and reclamation of active and passive sonar system and other devices on the deep ocean floor.

• Develop more economical and reliable welding (or other pressure-tight joining) techniques for thick metallic sections, including bi-metallic joints, for marine use. Special emphasis on deep diving submarine hulls where titanium and/or aluminum may replace steel in whole or in part. New materials concepts should be encouraged.

To aid and abet undersea search and kill, there is a need to:

• Improve marine propulsion and auxilliaries bearing size, geometry, and lubrication in order to reduce noise generation and transmission. Special emphasis on thrust bearings for deep diving submarines subject to high hydrostatic pressure. Partial answer may be in use of seawater or steam to replace conventional oil lubricants. Throughout undersea technology more effort should be made to use the sea ambient environment to improve marine engineering.

• Develop small-sized speed reducers of high torque capacity (as high as 65-to-1 reduction) producing minimum of noise in sonic and ultrasonic bands needed for torpedoes and thrust procedures and should be able to handle up to 1,000 shp. This technology might enable use of nuclear closed cycle gas turbines driving outboard propulsion system in some vessels.

• Develop static high dc power electric generators (fuel cell or thermoelectric). Used with specific characteristics static inverters for ac power conversion, system would eliminate motor-generator sets (a noise source). Advance in fuel cell technology could result in "dead-quit" submarine operation. Special emphasis on development of data leading to new techniques and hardware for attenuating or eliminating self noise, machinery noise (mechanical couplings), cavitation noise, and flow noise in ships and underwater mechanisms and installations.

• Create precise undersea surveying and navigation devices for reliable, extremely accurate determination of submerged vessel speed with respect to ocean bottom, an important factor in underwater missile launching. Also develop surface ship automatic pilot navigation.

• Design of anti-submarine hydrofoil for high-speed surface operation combined with efficient underwater capabilities. This could in effect be a hydrofoil deep depth sonar platform utilizing optimum sonar conditions for search. After search vehicle would surface and proceed to next search area. Phenomenal weight-to-horsepower ratio possible with new power plants used with lightweight metal hull.

• Accomplish breakthrough in generation, propagation, and reception of sound in ocean—or development of new devices—leading to a means of IFF for undersea surveillance. Chief problem today is to determine whether object detected by sonar is

A fundamental ingredient of success in any business or government undertaking is the exchange of information and ideas. In his article, Mr. Groves of Defense Systems Department, General Electric Company, Syracuse, N.Y., challenges the U.S. marine engineering community to seek rather than avoid encounters with hitherto unfamiliar and unformulated problems. Only with a unified approach to the marine and naval problems can the engineers and designers produce impressive breakthroughs in economic and scientific naval engineering and by way of these breakthroughs create a powerful naval fleet capable of meeting any threat.

friendly ship, a whale, a school of fish, a decoy or other countermeasure, or an enemy submarine. All give sonar reflections. Limitations on transmission in water where temperature changes, coupled with fact that acoustic methods are slow and inexact point to greater emphasis in development of non-acoustic systems such as deep-sea optical maser.

In the field of marine power—main proulsion as well as secondary and auxiliary power—there is a need to:

- Investigate the possibility of larger scale use of solid propellants for rocket underwater propulsion.
- Design various imaginative devices to use and convert some of the oceans thermal and hydrostatic energy. Sea water contains uranium for fission-produced power and deuterium or heavy hydrogen for thermonuclear power. Another possibility is to obtain ac or dc power from shafts turning at 50,000 to 100,000 rpm. Also needed are systems to transduce main propulsion schemes to secondary and auxiliary power. Novel cryogenic refrigeration (apparatus and dewars built in to ship) might provide key to make certain energy-conversion modes possible. Some of these conversion modes are:

  Nuclear Energy to **Thermal Energy** via Fission or Fusion Reactor or Ionized Plasma Fission Reactor to **Electrical Energy**

  Chemical Energy to **Thermal Energy** via Exothermic Chemical Reaction or Battery or Fuel Cell to **Electrical Energy**

  Thermal Energy to **Mechanical Energy** via Diesel or Turbine

  Thermal Energy to **Electrical Energy** via Thermal-Electric Devices

  Mechanical Energy to **Electrical Energy** via generator

  Electrical Energy to **Acceleration of a Water Column and Propulsion** via magnetohydrodynamic device

  Electrical Energy for Electric motors for propulsion and Auxiliary Power

  Thermal Energy to **Acceleration of A Water Column and Propulsion** via Hydrojet, or Rocket

  Mechanical Energy to Acceleration of a Water column and propulsion via reduction gearing-propeller, etc.

In addition to the problems listed above there is also an urgent need for further development and improvement in the following specific marine engineering problem areas:

- Nuclear propulsion reactor shielding.
- Coating material to reduce frictional drag (especially for underwater craft.)
- Water resistant grease.
- Underwater television and photography.
- Image intensification enhancement devices.
- New device to replace submarine periscopes.
- Underwater countermeasure devices and techniques.
- Surface and subsurface ship hull and propulsion design.
- New communication systems through the air-sea interface.
- Higher reliability, reduced maintenance, lower cost, and unattended systems program related to the electronic, electrical, mechanical, etc. systems of ships and crafts including aircraft.
- Life sciences associated with human tolerance to unusual environments.
- Anechoic engineering and application of visco-elastic materials.
- Increased use of solid state devices in practically all marine vehicle design.
- Hydrodynamic innovations—boundry layer control concepts.
- Sensors in acoustic and non-acoustic devices not limited to ASW detection, for use on merchant ships, submarines, aircraft, etc.
- Ambient sea noise research. Possible evolvement of detection techniques akin to those used in cosmic ray astronomy.
- Natural science programs to study bird, fish, and animal features which might be adapted for man's use.
- Inland Waterway icebreaker craft, possibly powered by water reactor and turbo-electric drive.
- Redesign of special submarines, ships, and aircraft for oceanographic purposes.
- More and better equipment for simulation of ocean environments.
- Less expensive, more effective overhaul and repair methods, particularly for nuclear submarines and naval aircraft.
- Small-size, broad-band sonar transducers.

Aside from the specific needs dealt with so far, the marine and naval engineering society is faced with a series of problems in general key areas with bearing on military as well as commercial interests. Again there is lack of a unified approach from industry's side, in spite of the benefits to be gained.

In these general key areas there is a need to:

- Establish an underwater commercial mining and salvaging technology to harvest some of the raw materials in the vast ocean. It is estimated that one square mile of ocean floor surface contains cobalt and manganese modules worth $0.5 million. Other commodities are oil, chemicals, and food. Emphasis is on development of inexpensive methods to bring these to the surface.
- Develop underwater shipping and storage techniques as well as logistical underwater and mid-ocean support base systems.
- Apply aircraft practices and vast pool of aerodynamic research to ship design. Ship shape and speed have not changed significantly in the past 50 years. There is tangible, translatable similarity in the disciplines of: Hydrodynamics (hydrofoils) and aerodynamics (airfoils); meteorology and oceanology; sound energy through temperature gradients and electromagnetic energy transmission in the ionosphere, and many others. There is also the applicability of space technology to marine engineering (navigation, communication, weather prediction, and reconnaissance satellites.)
- Increase hydrographic and oceanographic research. Despite much recent work in these fields results have not been applied or coordinated to utmost advantage. Perhaps this will be remedied through government's increased financial support of oceanographic research. Collected data is of no real value unless translated into devices, instructions, or practical rules.
- Establish fundamental data for predicting such things as metallurgical performance with respect to fatigue, locked in stresses, creep, ductility, notch effects, etc. Also for possible reappraisal and working coordination of ideas related to mechanics, energy conversation, electronics, etc, all of which point toward new material and design developments. Marine design and engineering requires the skills and cooperation of many specialists. So far the individuals have generally worked in separate groups with little real interchange. Growing awareness of need for interaction between groups will benefit the entire marine engineering field. ★

Bibliography:

In the main this unclassified information has been gathered from several sources both oral and written. The written record consists largely of the following:

Navy Research and Development Problems—Dept. of Navy, Washington, D.C., *Underwater Engineering Vol. 1*, Number 3, *Military Marketing Data Committee* Report of Electronic Industries Assoc.

UDT

. . . a human weapon

One of the most hi[illegible]fective combat organizations in the Armed For[illegible] Navy's Underwater Demolition Team (UDT). UDT grew out of World War II when it was found necessary to precede [illegible]head invasions with a force capable of locating and destroying the German first line of resistance—mines and underwater obstacles.

St. Thomas, in the Virgin Islands, is the scene of much UDT activity. From the pre-dawn hours till after dusk the day is filled with hard calisthenics and exercises. Training throughout the course is so intensive and strenuous that UDT men are officially classified as "weapons." After their [illegible] end Jungle Warfare and Jump School to [illegible] capabilities.

Today, because of the demands imposed by technological rivalry, UDT has far exceeded its original *raison d'etre*. Various types of submersibles, cameras, detonators and explosives, underwater communication devices and scuba equipment are constantly being experimented with in order to enhance the scope of UDT applications. Problems of major concern involve eliminating or reducing air bubbles from breathing appa-

[illegible] extending the speed and proficiency of swimmers and communication devices, improving gas mixtures to enable greater diving depths. R and D efforts directed in this area have yet to find their limits in the enigma of the deep.

PLASTIC PRESSURE HULLS

By Bud L. Duft and Norman Brink
Narmco R&D
Division of Telecomputing Corp.

THE SUBMERSIBLE STRUCTURE is now beginning an evolution similar to that of the airborne structure. Since over 70% of the oceans lie between 10,000 and 20,000 feet in depth, high strength hull structures which can withstand these pressures must be developed. Present metallic construction cannot be utilized at these depths and maintain positive buoyancy. Therefore, a lighter, more efficient material and structural concept must be evolved in order to provide positive buoyant, deep submersible hulls.

Composite construction of glass reinforced plastic is such an efficient structure. In general, all deep submersible structures are pressure vessels and, therefore, have directional stress requirements. By the use of directional materials, such as 143 glass cloth and/or filament-winding, in composite construction only the material needed in a particular direction needs to be added to the composite, to make the weight of the structure nearly 100% efficient. Whereas, in homogeneous metallic materials, additional weight must be incorporated to satisfy a load in one direction only, and may be only partially utilized in another direction.

Of all the glass reinforced plastics available to date, filament-wound composites offer the greatest strength-to-weight advantage. The density of this composite material is 0.065 to 0.070 pounds per cubic inch, and the state-of-the-art composite compression strength is 100,000 psi. However, Narmco has achieved compression strength values as high as 175,000 psi and has consistently achieved values of 150,000 psi.

Glass reinforced plastics are generally lower in compression than in tension because of the nature of the internal failure mechanics in the material. Tensile failures are usually a pure mechanical failure in the glass filament itself; whereas, compression failure is a combination of material failure and local instability of the fiber in its resin matrix. Since all glass reinforcement material produced at present is directed toward tensile applications, we are working to improve glass filaments for compression use by: Increasing the diameter of the fiber to increase its local section modulus and therefore its stability; studying the mechanics of failure by means of mathematical and experimental models; and stabilizing the filament by the utilization of more compatible resin.

This should result in the consistent production of composites with a nominal compression strength of 175,000 psi and modulus of elasticity of 6.7 x 10^6 psi.

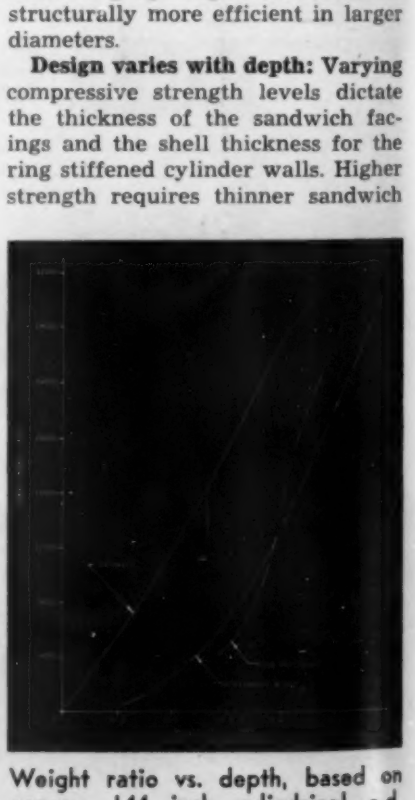
Design concepts utilizing these materials have been theoretically evaluated, and experimental substantiation is now in process. Design concepts under study include sandwich constructed, directionally wound shells, ring stiffened directionally wound shells, and unstiffened directionally wound shells.

This study was based on different diameters of approximately 6.25 and 144 inches with an approximate L/D ratio of 1.5. Other parameters held constant included composite compressive stresses of 100,000 psi and 175,000 psi with corresponding moduli of elasticity of 6.0 x 10^6 and 6.7 x 10^6 psi.

Effect of size, becomes immediately apparent by the choice of the two basic diameters, 6.25 and 144 inches. The weight ratio for the sandwich and unstiffened shell shows little change for the two diameters for the same strength level. For example, a 6.25-inch diameter sandwich cylinder with a strength level of 175,000 psi at 30,000 feet has a weight-to-displaced-water ratio of 0.448. However, the ring stiffened shell becomes more efficient as diameter goes up. In sandwich construction, the stiffening effect is derived from an increase in the core depth; in ring stiffened construction, the effect is derived primarily from ring spacing which becomes structurally more efficient in larger diameters.

Design varies with depth: Varying compressive strength levels dictate the thickness of the sandwich facings and the shell thickness for the ring stiffened cylinder walls. Higher strength requires thinner sandwich

Weight ratio vs. depth, based on approx. 6.25 inch cylindrical o.d. Length in all cases 10 inches.



Weight ratio vs. depth, based on approx. 144 inch cylindrical o.d. Length in all cases 216 inches.

facings and shell thickness. At moderate ocean depths, the thinner facings in the case of the sandwich cylinder wall result in the need of a greater total wall thickness, or greater core thickness, in order to satisfy the buckling criteria. The thinner shell for the ring stiffened cylinder wall requires that the critical distance between the rings be smaller to satisfy the buckling requirement.

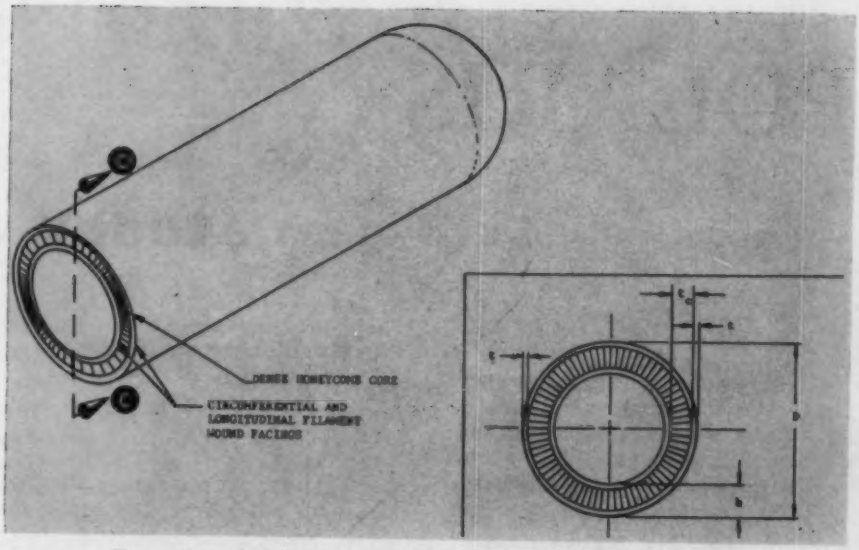
Despite the extra stiffening weight required for the two single wall concepts, the higher strength level indicates a lower ratio of weight to displaced water weight. The varying strength level does not have as great an effect on the unstiffened cylinder wall, since buckling criteria, rather than the strength requirement, determine the wall thickness at moderate depths.

Indications are that for ocean depths to about 30,000 feet, the sandwich and ring stiffened shell would be the most efficient on the basis of the weight ratio. In the case of the high strength level and small diameter, the sandwich wall construction concept is more efficient than the ring stiffened shell concept. For large diameter wall construction, the two single wall concepts are very competitive.

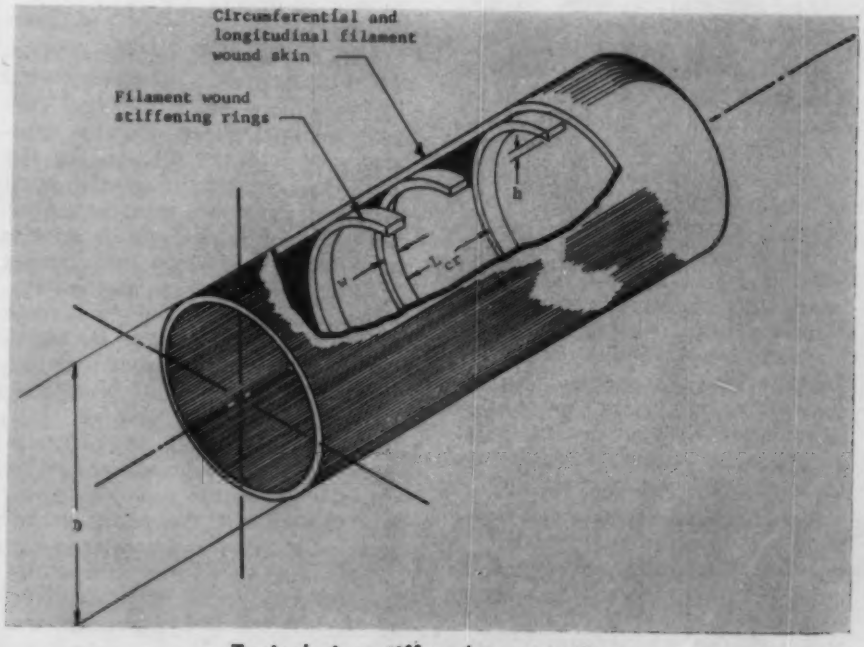
For depths below 30,000 feet all curves converge, and the unstiffened solid cylinder wall concept becomes efficient. This is due to several factors: First, the compressive strength of the material determines the wall facing thickness in both the sandwich and ring stiffened cylinder concepts. Hence, at extremely low ocean depths, material strength and not cylinder stability is the critical factor. In the case of the sandwich construction concept, the facing thickness becomes so thick, due to the strength requirement at extreme depths, that the core thickness approaches zero. The skin thickness for ring stiffened shell, on the other hand, increases sufficiently so that the critical buckling length becomes greater than the desired length of the cylinder wall.

Thus, it seems certain that deep submersible hulls of composite construction, utilizing glass reinforced plastic, can be designed with positive buoyancy for use at great ocean depths. It is also apparent that the design concept to be utilized will depend upon the mission requirements and the size of the structure.

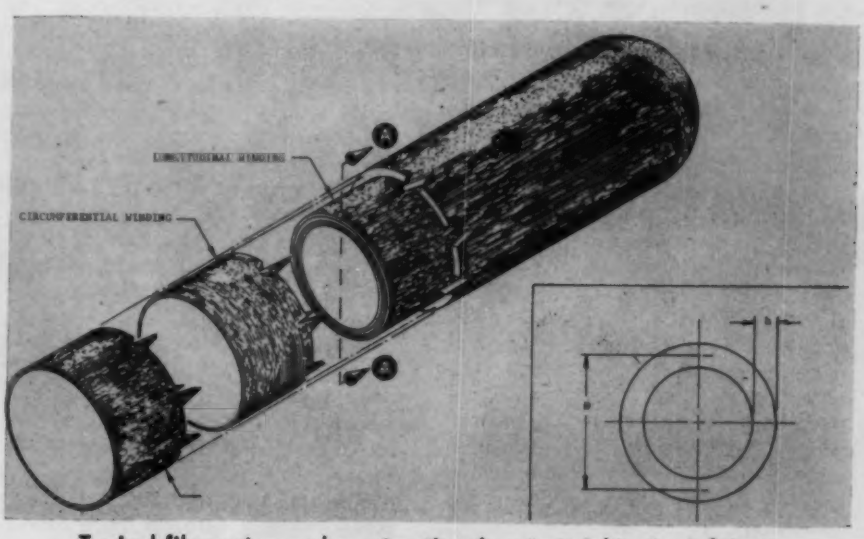
Additional advantages are available from the sandwich concept, such as the ability to absorb sound, shock loads, and provide facilities for boundary layer control. ★



Typical sandwich construction. Insert at right, view of C-C.



Typical ring stiffened construction.



Typical filament wound construction. Insert at right, view of A-A.

POLARIS . . .

. . . today and tomorrow

By Richard E. Munske

THE NAVY'S WONDER CHILD, POLARIS, still appears to be void of any Achilles heel. The big question is, how long can it stay this way? This depends not only on the missile, but its launching pad as well . . . the submarine.

Most important to the submarine is survival. Design considerations are established around the concept that the submarine must avoid detection, no less identification. Of course, as science progresses with time, enemy active and passive sonar — and possibly other techniques — will likewise improve, leaving POLARIS faced with greater susceptibility to detection. But, through intuitive foresight coupled with the technological efforts of industry, POLARIS seems to be in a pretty good position to maintain its high degree of immunity with countermeasures and improved undersea performance.

Reducing submarine noise to at least the level of that created by the ocean seems to be one of the most plausible methods of coping with passive sonar. Replacing electromechanical power with thermoelectric power would help eliminate one of the bigger sources of noise—60 cycle hum. Thermoelectric refrigeration is already being experimented with on subs and has more than proven its ability in noise reduction.

Several methods are offered to counteract active sonar. One would be to employ some device that could return emitted pings in a chaotic manner so as to confuse the enemy. This might defeat its own purpose though, since it is in itself a noise generator. Another method involves applying a material or coating on the outer surface of the submarine which would absorb the transmitted pings. This idea would, in effect, adhere to basic submarine design considerations (keep quiet; avoid detection).

Another major concern is protection against anti-submarine missiles. Decoys released from the sub could divert sonar-guided missiles from their intended target. Although there is much room for work in the anti-submarine-missile missiles field, there is no substitute for silence.

With the new and improved POLARIS A-3, precise launch position becomes more and more vital. Target destination is already programmed into the missile, but the sub's location, or more specific, point of missile departure, remains the one big variable. Since the submarine is a mobile missile site the distance between missile origin and destination will vary, resulting in azimuth error. This is handled with higher precision gyros and accelerometers. SINS (Ships Inertial Navigation System), generates position (latitude and longitude) and azimuth. A continuous program is now in effect whereby the basic equipment is retained, but the precision and quality of gyros and accelerometers are steadily improving. At this time, navigational measuring instruments better than the gyro are nonexistent.

Right now the Navy is considering building a new SINS around a single-degree gyro which would be used as a memory reference. This "electrostatic gyro monitor" will act as an artificial star to yield azimuth corrections. The Navy is scheduling this new gyro program to go into effect in 1962.

Other areas of endeavor for navigational aids are the mapping of magnetic and gravitational fields, and ocean floor topography. Topographical mapping with sonar requires an extremely narrow angle beam in order to secure any data of value. If the beam is too wide it may bounce off some obstacle not truly beneath the sub, and would, therefore, supply incorrect depth information.

Gravitational and magnetic field measurements demand more sophisticated instrumentation. Corrective devices may be needed to counteract sub-hull magnetism. Although, it would be more economical to suspend equipment from beneath the hull at a relatively safe distance (this figure is not available, but is within the limits of practicability) rather than to de-gauss the submarine.

Aside from navigational purposes, magnetic measurements can be applied to "un-sound" tracking and detection methods. During World War II a system called MAD (Magnetic Anomaly Detection) was used for submarine detection. Electromagnetic recordings made from aircraft revealed the presence of submerged submarines by detecting changes in the earth's magnetic field. Handicapped by short range limitations, it nevertheless affords positive classification and is invulnerable to jamming.

If the U.S. is studying magnetic anomalies, it is reasonable to assume that the enemy may also be capable of this method of detection. Couldn't this be counteracted with non-metallic hulls such as fiberglass or other composites? The David Taylor Model Basin has been performing studies on materials other than steel (see article p. 38, May/June issue) and have come up with some interesting results. Plastic hulls would offer no magnetic complications.

One phase of POLARIS-ology that has made a definite stride recently is the firing-time interval. When it comes to "pressing the button," a rapid firing sequence is mandatory to insure a safe retreat. The Mark 84, an improved fire control system, has decreased the time interval between POLARIS firings (previously 1 minute, now classified) through its ability to feed launching position data into the missiles.

All these concepts, whether in theory or reality, can and will be deciding factors in maintaining submarine supremacy.★

SPECIAL PUMP FOR HYDRAULIC TEST

By G. W. Asimos, Ensign, USNR
Aeronautical Materials Laboratory
Naval Air Materials Center

The Aeronautical Materials Laboratory (AML) of Naval Air Material Center (Philadelphia, Pa.), is one of BuWeap's principal research, development, test, and evaluation activities. It conducts research and development work on all materials any many processes connected with construction of Navy aircraft and related equipment. Investigations cover a range of materials such as plastics, rubber, metals, and coatings; many processes including welding and electroplating; and a variety of products including components for hydraulic control systems and air-sea rescue and survival equipment. The results of these investigations are disseminated to manufacturers and Government agencies. This information establishes design criteria.

The Equipment Division of the AML performs exploratory research evaluation and qualification testing of various aircraft hydraulic system components under exacting and rigorous requirements. Specialized and complex testing equipment is often necessary to meet these requirements and to carry out constant studies on new type hydraulic components. One valuable and versatile item of test equipment is a Denison hydraulic pump unit which was designed and fabricated for the Equipment Division to detailed specifications to meet test conditions.

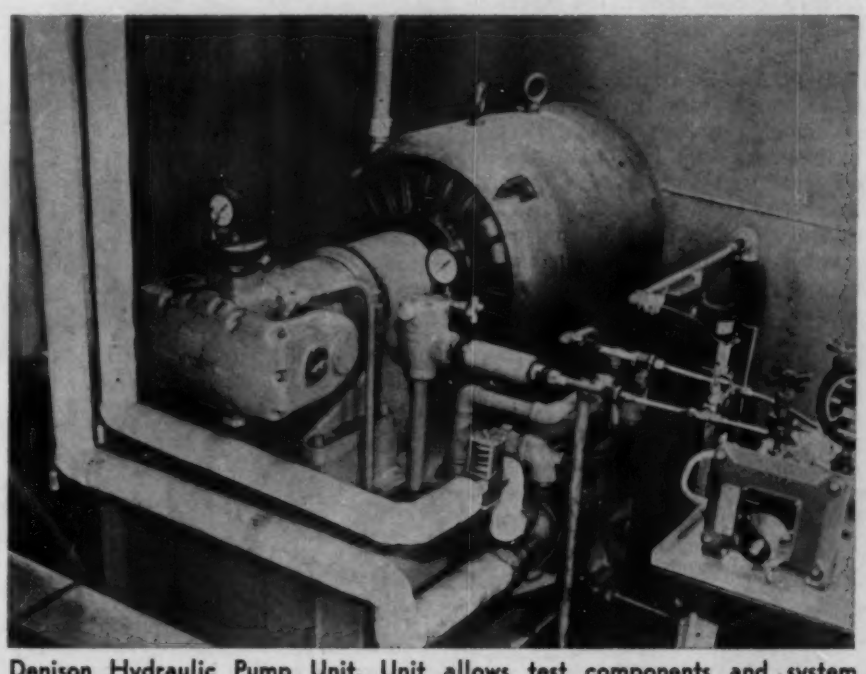
In this pump the delivered oil volume is varied by changing the length of piston strokes within the barrel, the strokes being controlled by the angle of the cam plate against which the pistons ride. Piston thrust is balanced by the admission of pressure through a drilling in the piston into an area in the surface of the piston shoe that contacts the cam plate. This area is slightly less than the effective piston area which results from the shoe being supported on an oil film at all times. The cylinder barrel is supported on a conventional-type port plate into which are machined support areas hydraulically balancing this portion of the pump. The radial load created by the angle of the cam plate is supported by a precision roller bearing which is placed at the point of average load, effectively balancing all radial forces. The cylinder barrel is driven by a spline, the center of which is located at the same point of average load resulting in the balancing of all driving forces. The cylinder barrel and piston shoes are manufactured from a nickel bronze, having excellent bearing qualities, abrasion resistance, high strength, pressure tightness, and the lowest expansion coefficient of all types of bronze.

The pump unit contains the following variable delivery controls: 1) hand wheel control which provides a means of manually setting the volume delivered by the pump; and 2) pressure compensating control which varies pressures. These variable delivery controls are bolted to the pump housing in easily removable units. All working parts are submerged in an oil bath. Also incorporated in the pump unit are a 100-gal. reservoir, a heat exchanger, a pressure gage, two 200-wire mesh filters, and two 10-micron filters. These features lend to ease of maintenance.

The pump unit is continually used in testing the performance of aircraft hydraulic components such as valves, accumulators, actuating cylinders and pressure regulators. It is presently performing tests following these requirements: cycle from 2,000 psi to 3,000 psi at a cycling rate of 150 cycles per min. and attaining a pressure build-up rate of 200,000 psi per sec. for 1,000,000 life cycles.

Another added feature of the unit is that it can be used for 275-degree F temperature testing merely by changing the material of the static seals. The unit has proved its versatility. Its features of compactness, low power consumption, variable flow control, and durability increase savings in time, labor, and money. ★

The opinions or assertions expressed in this article are the private one of the author and are not to be considered as official or reflecting the views of the Department of the Navy or the Naval service at large.



Denison Hydraulic Pump Unit. Unit allows test components and system mock-ups maximum flexibility of installation.

DOPPLER

use of common physical phenomenon aids analytical sonar techniques

By

A. N. Glennon

Although the Doppler Effect is common to all types of wave action, it is probably most familiar as a change in the observed pitch of a sound when its source passes by at a fairly high speed. When Doppler shift occurs in sonar, the source and the listener are usually both in motion, and the change in frequency is the result of both motions. Regardless of the speeds of the source and observer; however, the velocity of the sound itself is unchanged.

The effect on the observed frequency is slightly different for motion of the source than for motion of the observer. Since the difference is a second-order effect, it is usually ignored. To show how this difference comes about, the development which follows treats the two separately.

In Figure 1a a stationary source, S, is transmitting sound toward a stationary observer, O. Traveling at a velocity c, the sound reaches the observer in t seconds. The distance from S to O, then, is ct. Within this distance ct there will be a specific number of cycles of the sound, depending upon its frequency. If S now moves toward O at some speed v, as shown in Figure 1b, it will travel a distance vt in time t. Although the same number of cycles will be transmitted, the wave train will now occupy a shorter distance, ct-vt, and since c and v are uniform each cycle will be shortened proportionately. If the original wavelength of one cycle was L, the new wavelength will be:

$$L' = L\left(\frac{ct - vt}{ct}\right) = L\left(\frac{c - v}{c}\right) \quad (1)$$

If the source moved directly away from the observer, the wave would be elongated rather than compressed, and the new wavelength would be:

$$L' = L\left(\frac{c + v}{c}\right) \quad (2)$$

From these two cases, the Doppler Effect can be generalized for a moving source as:

$$L' = L\left(\frac{c - v\cos\theta}{c}\right) \quad (3)$$

where θ is the angle between the direction of travel of the source and the direction of wave travel in which we are interested. In fire control terminology, θ is the target angle of the source.

Since we are usually more interested in frequency than in wavelength, the relation $f = c/L$ may be applied to obtain:

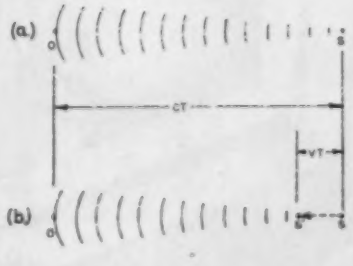


Figure 1. (a) Source and Observer stationary — No Doppler. (b) Source in motion toward Observer— Apparent increase in frequency.

$$f' = \frac{c}{L'} = \frac{f}{1 - \frac{v}{c}\cos\theta} \quad (4)$$

In Figure 2, the observer is moving directly toward a stationary source at a speed V. In time t, not only the

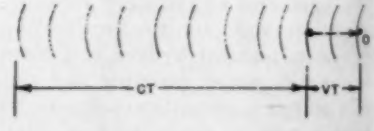


Figure 2. Observer in motion toward source—apparent increase in frequency.

waves contained in distance ct will pass the observer, but also those in distance Vt, the distance traveled toward the source in time t. The observer, then, has heard Vt/L more cycles of sound in time t than he would have heard had he been stationary. With the same reasoning as before, the apparent frequency is:

$$f' = f\,\frac{c + V}{V} \quad (5)$$

Similarly, when O is moving directly away away from S,

$$f' = f\,\frac{c - V}{V} \quad (6)$$

giving the general relationship:

$$f' = f\left(1 + \frac{V}{c}\cos\phi\right) \quad (7)$$

where ϕ is the relative bearing of the source from the observer.

The difference between the two cases of motion becomes apparent if

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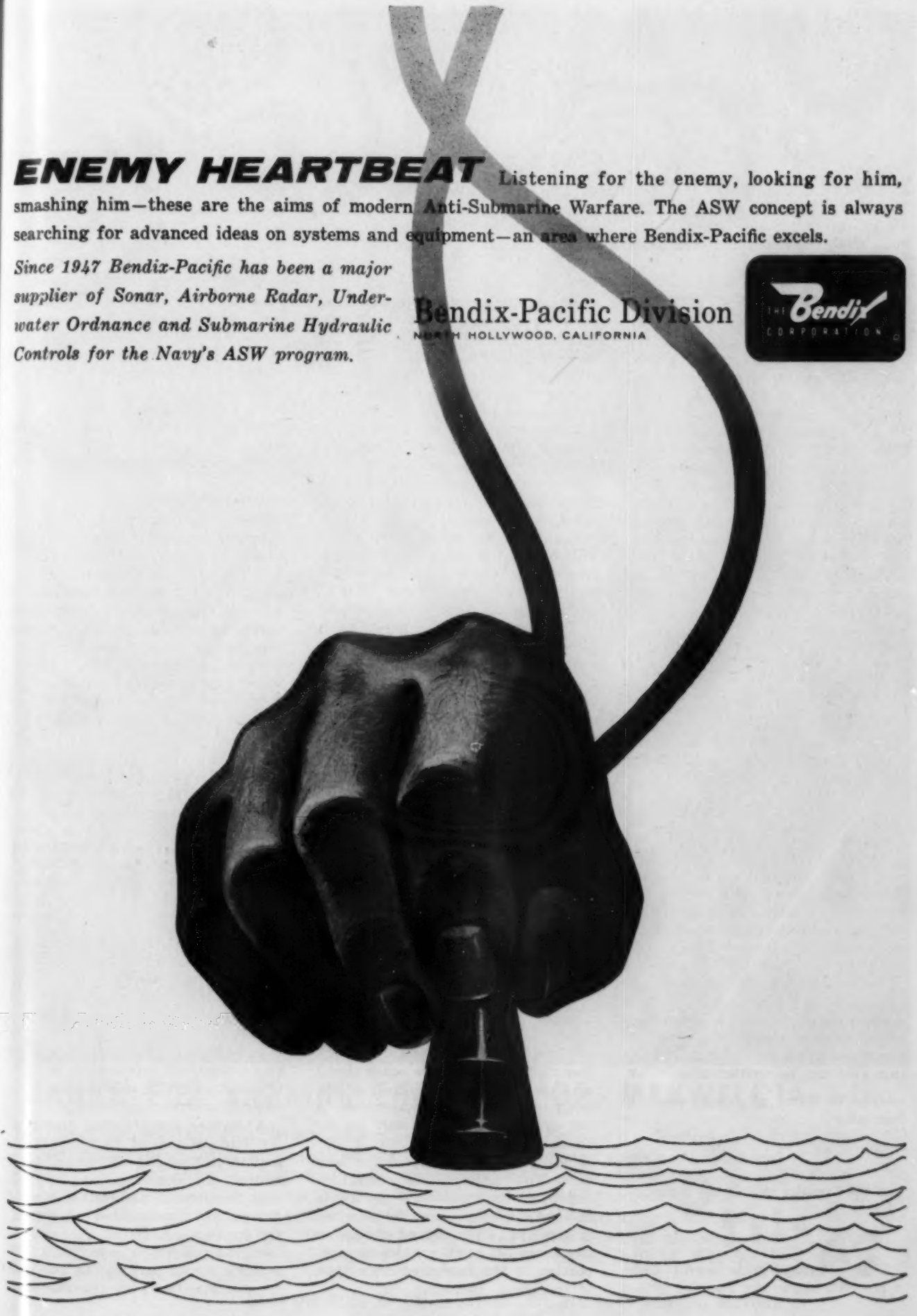

equation (4) is expanded for comparison with equation (7):

$$f' = f\left(1 + \frac{V}{c}\cos\theta + \frac{V^2}{c^2}\cos^2\theta + \ldots + \frac{V^n}{c^n}\cos^n\theta\right) \quad (4)$$

$$f' = f\left(1 + \frac{V}{c}\cos\phi\right) \quad (7)$$

Since cos θ cannot be greater than 1, and v/c is usually less than 0.01, the second and higher order terms in equation (4) contribute very little to the overall Doppler Effect, and for practical purposes it can be said that source motion and receiver motion contribute the same amount of Doppler.

In an echo ranging situation, S and O will usually both be in motion. The total Doppler Effect is found by combining equations (4) and (7). As a ping leaves S at a frequency f, the motion of S converts it to a different frequency by equation (4). The motion of O when the ping reaches it has an additional effect, given by equation (7). As the energy is reflected from O, it again undergoes the effect of equation (4) and when it is finally received as an echo by S, equation (7) again applies. The returned frequency in echo ranging then is:

$$f'' = f\left(\frac{1 + \frac{V}{c}\cos\phi}{1 - \frac{v}{c}\cos\theta}\right)^2 \quad (8)$$

In the simplest case, S and O are headed directly toward one another, and equation (8) becomes:

$$f'' = f\left(1 + \frac{v + V}{c}\right)^2$$

$$= f\left(1 + 2\frac{v+V}{c} + \frac{(v+V)^2}{c^2}\right) \quad (9)$$

Since the squared term in the expansion is usually less than 10^{-4}, it may be ignored to yield the approximation:

$$f'' = f\left(1 + 2\frac{v+V}{c}\right) \quad (10)$$

Thinking of v and V simply as components of source and observer speed along the line of sight, equation (10) can be written even more simply in terms of range rate, $\dot{R}$, becoming:

$$f'' = f\left(1 + \frac{2\dot{R}}{c}\right) \quad (11)$$

and the Doppler shift itself is simply

$$df = 2f\frac{\dot{R}}{c} \quad (12)$$

This relationship is useful since it not only shows the Doppler Effect to be proportional to both frequency and range rate, but also provides a convenient means for determining its magnitude in different situations. Insertion of numbers into approximate equation (12) shows the Doppler shift to be about 0.7 cycles per second per knot of range rate per kilocycle. For example, echo ranging at 20 kilocycles on a target with a 20 knot range rate would yield a shift of 0.7 x 20 x 20 = 280 cycles per second. In the same situation, had echo ranging frequency been 10 kilocycles, the shift would have been only 140 cycles per second.

Since the Doppler Effect is proportional to frequency, it has a characteristic that is often forgotten in discussions of its nature: its effect on "pitch" is different from its effect on frequency. If we could listen to the actual sounds involved in sonar transmissions, the change in musical pitch of a low frequency sound and the change in pitch of a high frequency sound would appear to be the same for a particular range rate, even though the change in cycles per second would be different. This happens because the change in frequency between notes in the musical scale is proportional to frequency, just as is the Doppler Effect. Unfortunately, the change in pitch due to Doppler Effect would be almost undistinguishable except at extremely high range rates, so some means of enhancing the subjective effect of the Doppler shift is required in sonar systems. In the past, this has been done by means of a heterodyning process.

To the uninitiated, a ping or echo from one sonar sounds pretty much like those from another, because most sonars use a beat frequency oscillator set to give an audio output in the neighborhood of 800 to 1200 cycles per second. This low audio frequency was selected as a result of extensive tests as the least fatiguing pitch for the average ear. A side benefit to this frequency is Doppler enhancement.

Since the heterodyning process yields the difference between the two frequencies involved, any Doppler shift present in the sonar signal appears in the audio output of the sonar unchanged in magnitude: a 280 cycles per second shift in the sonar frequency will give a 280 cycles per second shift in the beat note. This preservation magnitude improves the operator's ability to detect Doppler because the relatively few cycles per second change in frequency is much greater in proportion to the beat frequency than to the sonar frequency.

Although the Doppler Effect is a readily detectable phenomenon arising from known causes, its potential as a useful element of information in antisubmarine systems has seldom been realized. Sonar operators are trained to listen for it, and they report "Up Doppler" if an echo comes back at a higher pitch than the ping, and as "Down Doppler" if it comes back lower in pitch. In addition, they try to render shades of judgment by reporting "Slight up Doppler" or "Marked down Doppler". Interpretation of the sonarman's report, however, depends on the particular sonar equipment as well as the operator's experience with the gear. An operator whose main experience has been with the frequency sonar will seldom report anything more than slight up or down Doppler if he shifts to a low frequency sonar. The Doppler shift simply doesn't involve enough cycles per second at low frequency for him to detect a distinctive change in pitch, even with the enhancement given by the beat frequency oscillator.

As frequencies get lower and sonic power increases, detection ranges increase, adding to the burden of the operator. Extremely good pitch memory is required in a sonarman, to retain the sound of the outgoing ping for the time it takes to reach a target and return at a very slightly different frequency. His ability to compare the two sounds in his "mental ear" is no longer as good as it was with the sonars of World War II.

These difficulties, less Doppler shift and increased time delay between outgoing and incoming pulses, point up the necessity of including some electronic means of Doppler detection in future sonars. There are other considerations as well that make this both necessary and desirable.

Although Doppler shift can be detected and measured electronically, the subjective report of the sonarman has long been the only source of Doppler information used by the US Navy. In recent years, we have begun to realize that measured Doppler can provide refinements in ASW fire control, giving us solutions more speedily and more accurately.

A further complicating factor in the current use of Doppler information is that the sonarman hears neither the outgoing ping nor its beat frequency. The receiver is dead during the transmission of a ping, for its own protection. As soon as the transmission is completed, the receiver comes back on the line, and the operator hears the reverberation

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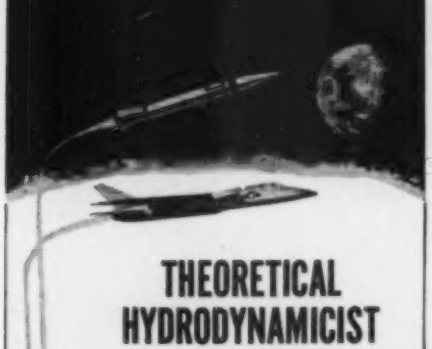

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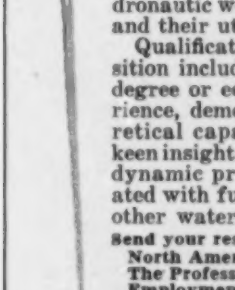

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COLUMBUS DIVISION
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Circle Reply Card No. 13

of the outgoing ping. Since reverberation is backscatter from essentially stationary objects, there is already some Doppler due to own ship's motion within the reverberation. Unless reverberation is processed before the operator hears it, he will hear a different tone on each relative bearing he trains his beam to. In this type of sonar, some of which have been used by the Navy, absence of any Doppler shift indicates a beam aspect target, while up Doppler shows something between a beam and bow aspect. However, in carrying out a search, the constantly changing pitch of the reverberation can become confusing to the operator.

Most of today's sonars have an Own Doppler Nullifier circuit built into them. This circuit changes the frequency of the beat frequency oscillator slightly as the audio beam is trained, to eliminate the effect of own speed on the audio signal. The pitch of the reverberation then remains constant regardless of the direction in which the beam is trained. Interpretation of observed Doppler is slightly different in this type of sonar: it indicates range rate, rather than target heading.

Use of the Doppler effect is not confined to detection and tracking equipment; weapons can make use of it in different ways. In any active acoustic weapon, circuits can be designed to react to Doppler. For example, a Doppler fuse could be provided to fire a torpedo or depth charge warhead on a near miss.

Referring to Figure 3, it is apparent that the Doppler shift becomes zero when the approaching source and receiver reach their closest point of approach. Simultaneously, the rate at which the Doppler shift is changing is maximum. Either or both of these effects could be used to set off a fuse. At the same time, protection against firing at greater than lethal range can be provided by setting some minimum rate of change of Doppler below which the weapon will not fire.

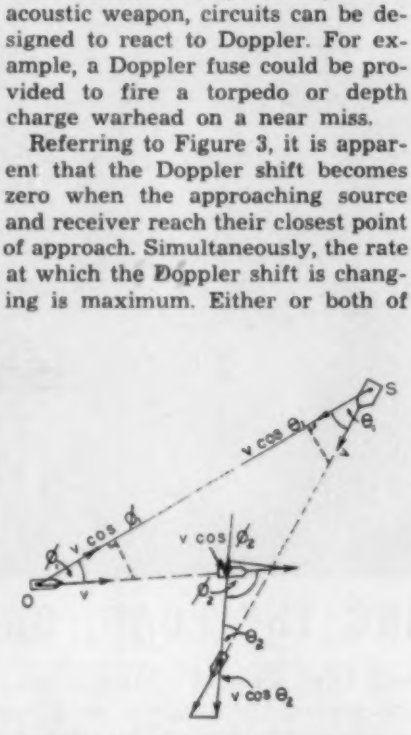

Figure 3. Source and observer in motion. Components of range rate producing (1) Up Doppler, (2) Down Doppler. At some position between positions 1 and 2, S and O reached their closest point of approach and Doppler was zero.

Another use to which Doppler may be put is in target indentification. By proper setting of Doppler detectection circuits, a weapon could be made to ignore any contact whose Doppler does not indicate a speed above some set lower limit, or to ignore a target at too high a speed, if this were desirable.

Other potential uses for the Doppler Effect lie in the fields of navigation and minehunting. Analysis of Doppler Effect from bottom reverberation could lead to an accurate shallow-water log. Adaptation of the principles used in moving target indicator radars to a mine-hunting sonar might result in a cleaner presentation of bottom-laid or moored mines through the elimination of surface clutter.

The Doppler Effect must always be borne in mind in designing any sonar. Since background noise is distributed over the entire acoustic spectrum, a considerable amount of unwanted noise can be eliminated simply by using the narrowest bandwidth possible. In some sonar designs, the Doppler Effect may be the limiting factor on bandwidth. For example, in the 20 kc region it was shown that the Doppler shift is about 14 cycles per knot of range rate. If technological advances should ever make it reasonable to require that a sonar be capable of handling 50-knot opening or closing range rates, a 20 kc sonar would have to have a 1400 cycle bandwidth. Similarly, a 5 kc sonar would require at least a 350 cycle bandwidth to accomodate this Doppler.

The Doppler Effect is, so to speak, a bonus effect in sonar. Submarines can be detected and attacked successfully without ever considering Doppler, and acoustic weapons can operate effectively without any Doppler information. On the other hand, since Doppler is present, free of charge, in any relative situation, the designer of sonar equipment should always be considering whether his gear might not be improved if he took advantage of its presence. ★

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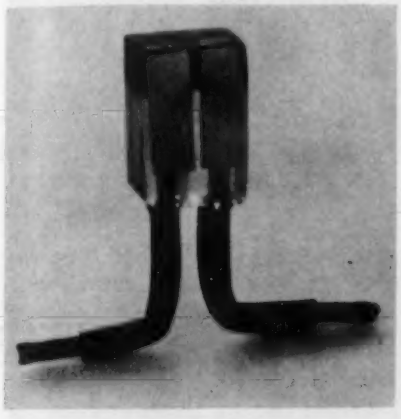
new USI products

Thermoelectric Module

Sela Electronics Company has announced a new Sela CORON thermoelectric module for temperature regulation and power generation. Among the unlimited uses of the CORON are cooling or heating of electronic systems and



components, laboratory equipment, and compact underwater units, as well as reliable maintenance of constant temperature. The units are available in 1, 2, 4 and 8 couple modules, in encapsulated or non-encapsulated forms.

Circle Reply Card No. 101

Hi-Lok Fasteners

Hi-Shear Corp. is manufacturing self-locking fasteners for use in current submarine construction and repair work. Basically a threaded fastener, it includes a threaded pin and a self-locking threaded collar.

Circle Reply Card No. 102

Roll, Pitch & Yaw

Five models of Angular Accelerometers for sensing roll, pitch and yaw cover a range of 0.5 to 500 rad/sec². Flexure pivots eliminate hysteresis for better resolution of the Dynamic Measurements Co. units.

Circle Reply Card No. 103

"Lie-Down" Relay

Designed primarily for component board use, a new micro-miniature relay with a seated height of only 0.45 in. has been introduced by Babcock Relays. The unit features plug-in terminal design.

Circle Reply Card No. 104

V-Fin Carrier

The collection of reliable data from the oceans may be expedited by the use of the V-Fin (Vehicle for INstrumentation) developed by Braincon Corp. The fiberglass submarine carrier, weighing 14½ pounds, carries all instrumentation in a watertight compartment.

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A line of subminiature, precision, snap-action switches has been announced by Fansteel Metallurgical Corp. A unique "cricket" action used in the contact-carrying leaf spring of the switch achieves uniform stress and reduction in metal fatigue.

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Transducer

A new transducer for sea water temperature measurement is being produced by Trans-Sonics, Inc. Calibration is expressed as mu/v versus temperature over the range of −5°C to +30°C.

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Plastic Conductor

A new plastic material, developed by Mesa Plastics, has very nearly ideal conductive properties in direct contradistinction to the normal concept of plastics. Ideal for flush-surface printed circuits.

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Sonar Pinger

A sounding device, produced by Edgerton, Germeshausen, & Grier, Inc., is designed to measure distances between the ocean floor and oceanographic equipment such as a grab, or a camera. With an accuracy to within 3 feet, the Pinger has been used successfully at depths greater than 4 miles.

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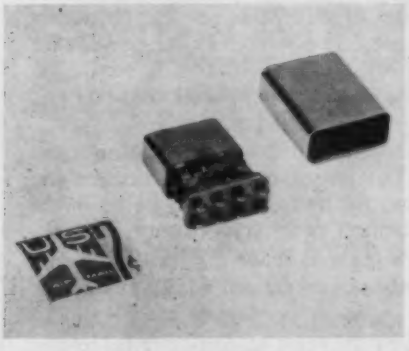
"Stamp-Size" Relay

The Series MM-22 microminiature relay, manufactured by Automatic Electric, incorpo-



rates a number of unique features in order to maintain reliability. Minimum contact life is 100,000 operations at 3 amps.

Circle Reply Card No. 110

Salt Spray Chamber

Wyle Labs announced a new self-contained, automatically controlled salt spray chamber. The fiber-glass-resin test compartment is 9 cu. ft. and has a water seal around the chambers top edge to prevent salt fog from seeping out.

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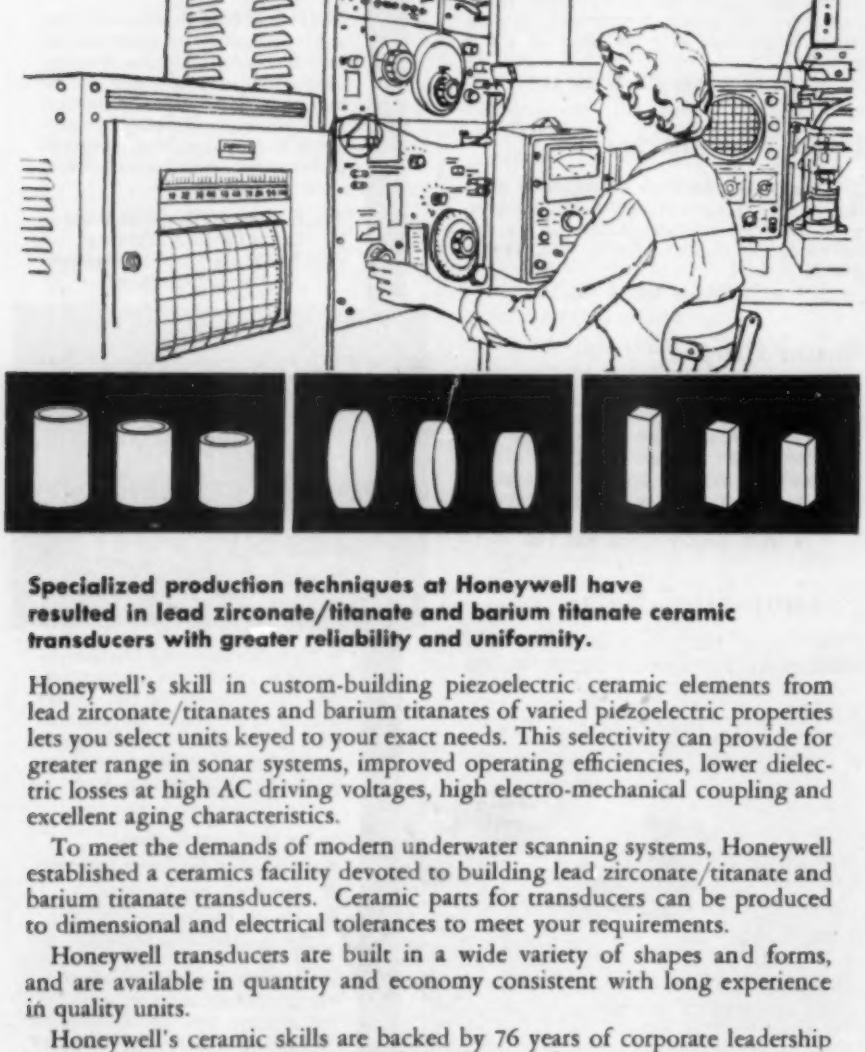

Specialized production techniques at Honeywell have resulted in lead zirconate/titanate and barium titanate ceramic transducers with greater reliability and uniformity.

Honeywell's skill in custom-building piezoelectric ceramic elements from lead zirconate/titanates and barium titanates of varied piezoelectric properties lets you select units keyed to your exact needs. This selectivity can provide for greater range in sonar systems, improved operating efficiencies, lower dielectric losses at high AC driving voltages, high electro-mechanical coupling and excellent aging characteristics.

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3-Axis Accelerometer

A hermetically-sealed 3-axis linear accelerometer, with range capability from ±2G's to ±200G's, is available from Humphrey, Inc. The device measures 2½ in. in diam. and 2 in. high, and weighs 10 ounces.

Circle Reply Card No. 129

Gyro Tester

A frequency response test fixture, Model FR01, produced by Humphrey, Inc., provides

for dynamic tests on rate gyros, integrating gyros and accelerometers. Speed range is from 1 to 25 cps.

Circle Reply Card No. 130

Inclinometer

Braincon Corp. has announced a new Type 109 Inclinometer which measures the tilt or inclination of submerged objects. Angle measurements can be made from 5° to 35° with tolerances of 1° or less.

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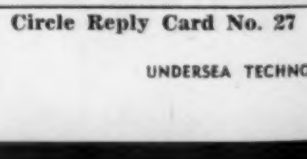

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Circle Reply Card No. 27

Static Inverter

Arnold Magnetics announces a series of miniature oil-filled power supplies which maintain high efficiency at extremely low power levels in applications up to 10 kv. Units operate at a minimum of 50 per cent efficiency at 3 watts.

Circle Reply Card No. 112

Underwater Recorders

Alden Electronic & Impulse Recording Equipment Co. recently developed a depth recorder (up to 4000 fathoms), and a high resolution underwater sound recorder. Both units are helix recorders which provide printout on sensitive paper by ion deposition.

Circle Reply Card No. 113

Sound Level Meter

H. H. Scott, Inc. announces a new sound level meter, which operates over the wide frequency range of 5 cps to 30 KC, and is powered by two batteries and a single bias cell. A ceramic microphone allows it to be used in temperatures from 0 to 170 degrees.

Circle Reply Card No. 114

Silicon Micro-Diodes

The General Instrument Corp. announces the availability of a series of silicon micro-

diodes for computer and general purpose applications. Peak inverse voltages range from 40 to 100 volts, with power dissipation of 250 MW.

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"Noiseless" Transducer

A new piezoelectric transducer—85 per cent quieter than most conventional transducers—is being manufactured by Mirax. The unit can measure shock velocity, blast pressure, wave durations, force and other parameters.

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A general purpose pressure cell, for precise measuring of fluid pressures in a wide range of applications, has been introduced by Baldwin-Lima-Hamilton Corp. Rugged construction assures long-term stability.

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Mesa Transistor

A high-speed NPN silicon epitaxial mesa switching transistor has been introduced by Motorola Semiconductor Products, Inc. One of the fastest switching transistors, the unit has a typical storage time of 16 nano-seconds.

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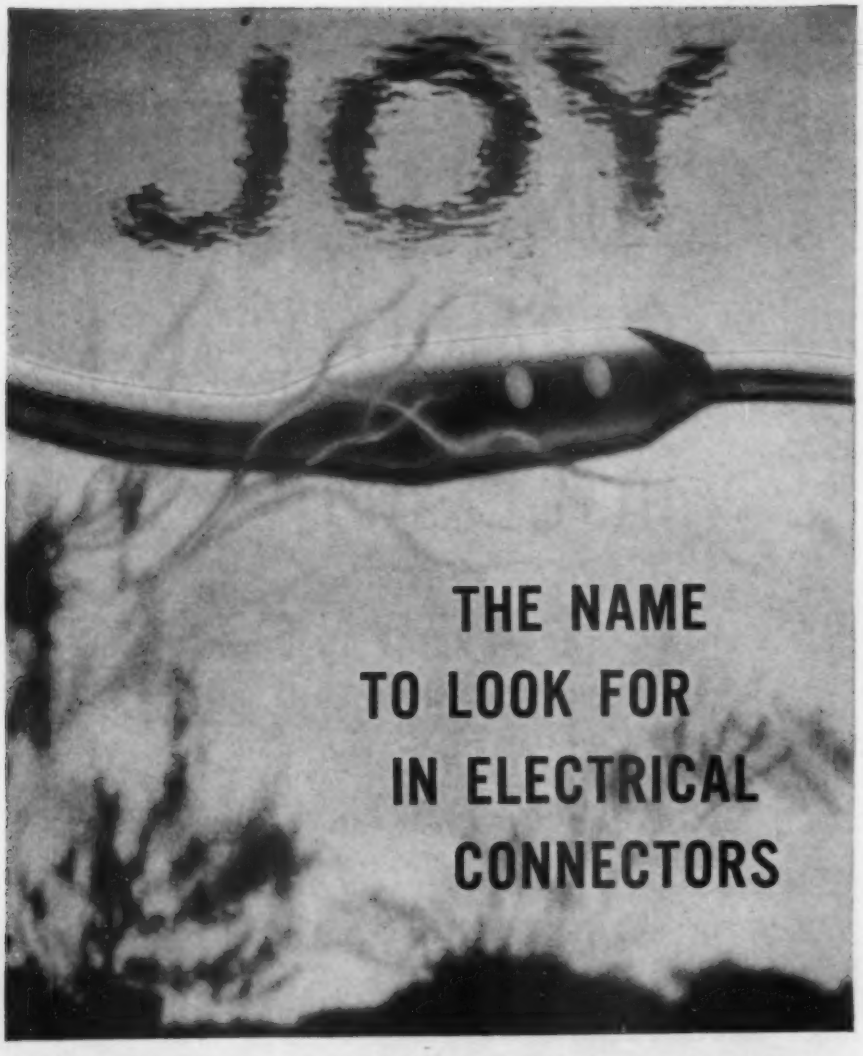

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USL *literature*

Filament Wound Subs

Zenith Plastics Div of 3M Co. has made available a small brochure on structural filament wound submarines. Included is a paper on "Reinforced Plastics for Hydrospace Vehicles."

Circle Reply Card No. 120

Undersea Consultants

Underwater Systems, Inc., acting as technical consultants for Byrd Undersea Technology, Inc., has released a brochure covering their facilities and services.

Circle Reply Card No. 121

Designers Handbook

A comparative study of high-frequency silicon transistors, produced by 4 major manufacturers, has been published in a DESIGNERS HANDBOOK by the Semiconductor Div. of Raytheon.

Circle Reply Card No. 122

Flat Cable

Spectra Strip Wire & Cable has available literature on their new extensible cable. Cable can be supplied with any number of conductors, nos. 10-30 AWG. Engineering charts are available.

Circle Reply Card No. 123

Cable Capacitance

A capacitance calculator, in the form of a nomograph, has been issued by GE's Wire and Cable Dept. User can estimate cable capacitance or conductor size and/or insulation wall thicknesses.

Circle Reply Card No. 124

Thermoelectricity

A bulletin entitled "The Coming Age of Thermoelectricity," available from Harco Labs, Inc., points out the present state of this science and future applications. Specifications on Harco products are also included.

Circle Reply Card No. 125

Thermo Electronic

A 4-page bulletin (No. 67), from Thermo Electric Co., describes compact thermo electronic self-balancing indicators and indicator controllers. Included are operating principles, features, and applications.

Circle Reply Card No. 126

Facilities Brochure

Marotta Valve Corp. describes their engineering, production and other facilities in a pictorial 24-page brochure. The company manufactures a variety of pneumatic and hydraulic control valves for missiles, submarines, etc.

Circle Reply Card No. 127

"Relay Terms"

A booklet titled "Definitions of Relay Terms" has been published by the National Assn. of Relay Mfgs. The booklet also includes several figures of basic contact forms.

Circle Reply Card No. 128

ust people

The election of **Chester W. Nimitz, Jr. (RAdm, USN, Ret)** as a Vice President of the Perkin-Elmer Corp. and General Manager of its Instrumentation Div. was recently announced. Mr. Nimitz, a former submarine commander, resigned from Texas Instruments, Inc. to accept the position.

Leo Botwin has been promoted to Assistant Chief Engineer of Norden Div/United Aircraft Corp. His new assignment will include directing advanced military programs utilizing new techniques in radar, TV and navigational systems.

John C. Parham has been appointed Manager of Navy Programs for Motorola's Military Electronics Div. A graduate of the Naval Academy, Mr. Parham retired as Rear Admiral in 1959 after 28 years of Naval service.

NIMITZ

PARHAM

William R. Ryan has moved up from Vice President/Engineering to Executive Vice President of Edo Corp. Mr. Ryan has participated in and directed the development of sonar equipment and sonar transducers.

Capt. Thomas W. Rogers, USN (Ret) has joined the Wash., D. C., staff of Maxson Electronics Corp. after 30 years in the Navy. His electronic experience is expected to assist Maxson in expanding their technical services in the D.C. area.

Dr. Vee Chang Tsien has been appointed Technical Assistant to the Vice President of the Marine Equipment Dept. of Nortronics. Prior to joining Nortronics Dr. Tsien was responsible for ICBM control systems development at Avco/Rad.

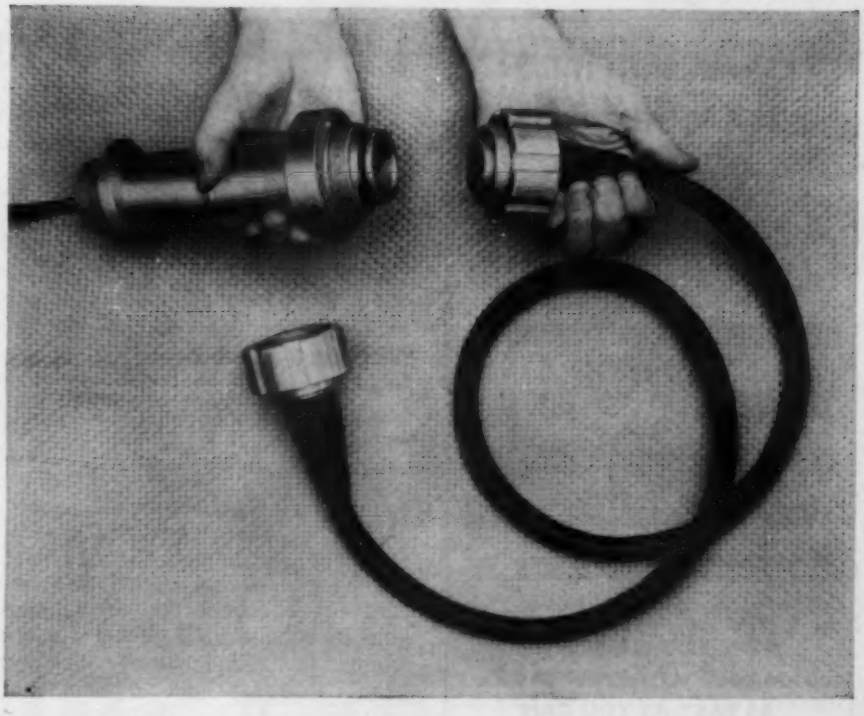
Thomas M. Sullivan has been named chief of Undersea Warfare in Research & Engineering Requirements (RER) at Tapco, a division of Thompson Ramo Wooldridge, Inc., after being associated with Fairchild Corp. for 18 years.

Bay State Electronics Corp. has appointed **John Ohman** as Head, Physical Sciences where he will be active in Bay State's R&D program emphasizing oceanography and geophysical experimentation.

Modesto Matarrese has joined General Precision as Program Coordinator of the Anti-Submarine Warfare efforts, Los Angeles Engineering Group. Mr. Matarrese was formerly Asst. Chief of ASW at the El Segundo Div. of Douglas Aircraft.

Arthur J. Burgess, Jr., who was assistant project manager on the SUBROC missile system with the Naval Ordnance Lab, was appointed an engineering representative for Consolidated Systems Corp.

After 30 years of active service in the Navy, **Capt. Eugene Tatom** has joined United Aircraft Corp.'s Norden Div. as Chief—R&D. Experienced in ASW, submarine detection and undersea rockets, Capt. Tatom's responsibilities will include activities in communications, stabilization and navigation.



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LETTERS TO THE EDITOR

Identification . . . . .

To The Editor:

We were glad to see you publish Kenneth Gentry's article on the Saclant ASW Center in the May/June issue of UST (p. 32), except for the fact that you did not identify him in his new Motorola position.

C. W. Bailey
Advertising and Public Relations
Dept. Military Electronics, Div.
Motorola Inc.

It was an oversight on UST's part. Captain Gentry, well known in ASW circles, joined Motorola, Inc. after retiring from U. S. Navy in 1960. He is responsible for planning and coordinating the Military Electronics Div.'s Undersea Warfare and EMC Research and Development programs.—Ed.

Oversubscribed

To The Editor:

Many thanks for passing on to me the May/June issue of UNDERSEA TECHNOLOGY.

You are to be congratulated on an excellent publication, and I am looking forward with interest to see forthcoming issues. We are just on the verge of working on some programs in this field of endeavor, and will derive great value from seeing UST regularly. I am wondering, therefore, whether it would be possible for us to be placed on your circulation list.

John Joss
Assistant to the Vice-President
Decca Navigator System, Inc.

The above letter is just one sample of the multitude of similar letters arriving at our office daily. At the present time we have about 3,000 qualified applications for our controlled unpaid circulation list, with a rather long waiting time. In the meantime, UST is available on a paid basis, at $4.00 per year or $7.00 for two years.—Ed.

Bemuddled Periscope!

Dear Captain Nemo:

I see by the "Heel and Toe Watch" in the May/June, 1961, issue of UST that SUBROC is undergoing live underwater firing tests at China Lake. I hate to disappoint an old seafarer such as you, Cap'n, but after a dry winter the water level in China Lake is probably ten feet *below* the lake bottom!

Oh well, one never does know what to expect next in the Mojave Desert.

W. J. Werback, Analysis Branch
Weapons Development Department
U. S. N. O. T. S.
China Lake, California

P. S. We do not live in a houseboat, either.

Our face, like the cover of the magazine, is red. It must have been sand bemuddling our periscope, or perhaps we just misread the statement from a friend of ours at Goodyear. We also had another error—this one a typographical slip—in stating the SUBROC would become operational in 1963. That should have, I hope, read 1962. Anyhow, we are glad to hear from you and to know that you read our magazine.—Captain Nemo

P.S. Perhaps the source of our confusion was that you are conducting "dry runs" of underwater launches at China Lake!

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Heel and Toe Watch

This issue's editorial takes off on the security system. This was done without malice of forethought. What finally set us off was the following item which appeared in the June 19 issue of U.S. Commerce Department's Synopsis of U.S. Government Proposed Procurement, Sales and Contract Awards:

"Acoustic tracking system to be capable of providing range and bearing information to surface or shore instrumentation as well as to the submarines at submarine speeds up to 35 knots, installation and testing of all electronic instrumentations aboard the Laboratory Ship at Charleston, S.C.—Est. $164,255—International Business Machines Corp. . . "

This is the first official mention of submerged submarine speeds since President Truman said "over 20 knots". Now if someone will just give the Russians our operational depth . . .

Project Moray has hit a snag: If all the gear that would be needed for such an interceptor type craft were installed, said craft would sink or get bigger. Either way it's no good. This is much tossed about project to build miniature high speed submarines which would be carried about by a mother craft until ready to go out and do a specific seek and kill job.

Just in case you missed it when it first was released, super-silent *Thresher* carries over 1,000 transducers and hydrophones installed along length of her hull. As they say, "She's all ears."

Pacific POLARIS base will be constructed at Pearl Harbor. For the moment POLARIS is strictly an Atlantic type weapon. Meanwhile, REGULUS is holding down the submarine strategic bombardment mission in the Pacific.

A puzzler the Navy would like to see solved: There may be an electromagnetic window in the ocean. Quite a few times over the last several years, surface ship radar has picked up and tracked submerged submarines. Phenomenon occurs without warning or explanation; ceases just as suddenly. Nobody has been able to come up with a "why" or a means of accomplishing this at will. For moment, freak is far too infrequent to have any tactical value, but if someone could find out why and how . . .

Navy wants a weapon which will sink very slowly while searching both down and horizontally for a target, and then take off for the attack.

Navy's encouraging American firms to participate in the North Atlantic Treaty Organization small submarine design competition. Even though U.S. figures it has to have big, rugged submersibles with far ranging staying power, it does think that small anti-submarine submarines will do a good job of protecting Europe where distances are shorter, supply bases closer. So far West Germany appears to be in the lead, with Italy and France pushing close on her heels. Britain is going the big boat route. U.S. Navy figures aircraft and missile design knowhow will pay dividends in this instance. Power plant will probably be based on fuel cells.

Submarine production capacity of present U.S. yards is limited to 10 SS(B)Ns plus 10 SSNs a year, according to information released in this year's appropriation hearings.

BBR is the newest, highest security classification. It stands for "Burn Before Reading"!

Captain Nemo

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The Electronics Div.
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The Bendix Corp.
Shaw Advertising, Inc.

The Bendix Corp. 31
Scintilla Div.
MacManus, John & Adams, Inc.

Brunswick Corp. 13
Defense Products Div.
McCann-Erickson, Inc.

Ceramics Laboratory 27
Minneapolis-Honeywell Regu'ator Co.
Foote, Cone & Belding

Cohu Electronics, Inc. 7
Massa Div.
L. K. Frank Co., Inc.

Columbus Div. 26
North American Aviation
Batten, Barton, Durstine & Osborn, Inc.

Defense Products Div. 13
Brunswick Corp.
McCann-Erickson, Inc.

Dittmore-Freimuth Corp. 32

Edo Corp. 11
Davis, Parsons & Strohmeier, Inc.

Electrical Products Div. 30
Joy Manufacturing Co.
Batz-Hodgson-Neuwoehner, Inc.

Frontier 28

General Dynamics/Electronics 5
Military Products Div.
D'Arcy Advertising Co.

General Electric 28
Heavy Military Electronics Dept.
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General Motors Corp. 25
AC Spark Plug
The Electronics Div.
D. P. Brother & Co.

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Librascope Div.
Compton Advertising, Inc.

Goodwin Engineering Corp. 12

Heavy Military Electronics Dept. 28
General Electric
Deutsch & Shea, Inc.

Joy Manufacturing Co. 30
Electrical Products Div.
Batz-Hodgson-Neuwoehner, Inc.

Librascope Div. ....inside front cover
General Precision, Inc.
Compton Advertising, Inc.

Ling-Temco Electronics, Inc. 9
Ling Electronics Div.
MacManus, John & Adams, Inc.

Marsh & Marine Manufacturing Co. 8
F. W. Harvey Advertising

Massa Div. 7
Cohu Electronics, Inc.
L. K. Frank Co., Inc.

Mech-Tronics Corp. 33
Hollander, Weghorn, Morrow Advertising Agency

Military Products Div. 5
General Dynamics/Electronics
D'Arcy Advertising Co.

Minneapolis-Honeywell Regu'ator Co. 27
Ceramics Laboratory
Foote, Cone & Belding

Monarch Personnel 33

North American Aviation 26
Columbus Div.
Batten, Barton, Durstine & Osborn, Inc.

PneumoDynamics Corp. 14

Scintilla Div. 31
The Bendix Corp.
MacManus, John & Adams, Inc.

Simplex Wire & Cable Co. .....back cover
Henry A. Loudon Advertising, Inc.

Systems Management Div. ..... Inside back cover
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MacManus, John & Adams, Inc.

United States Underseas Cable Corp. 3
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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

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250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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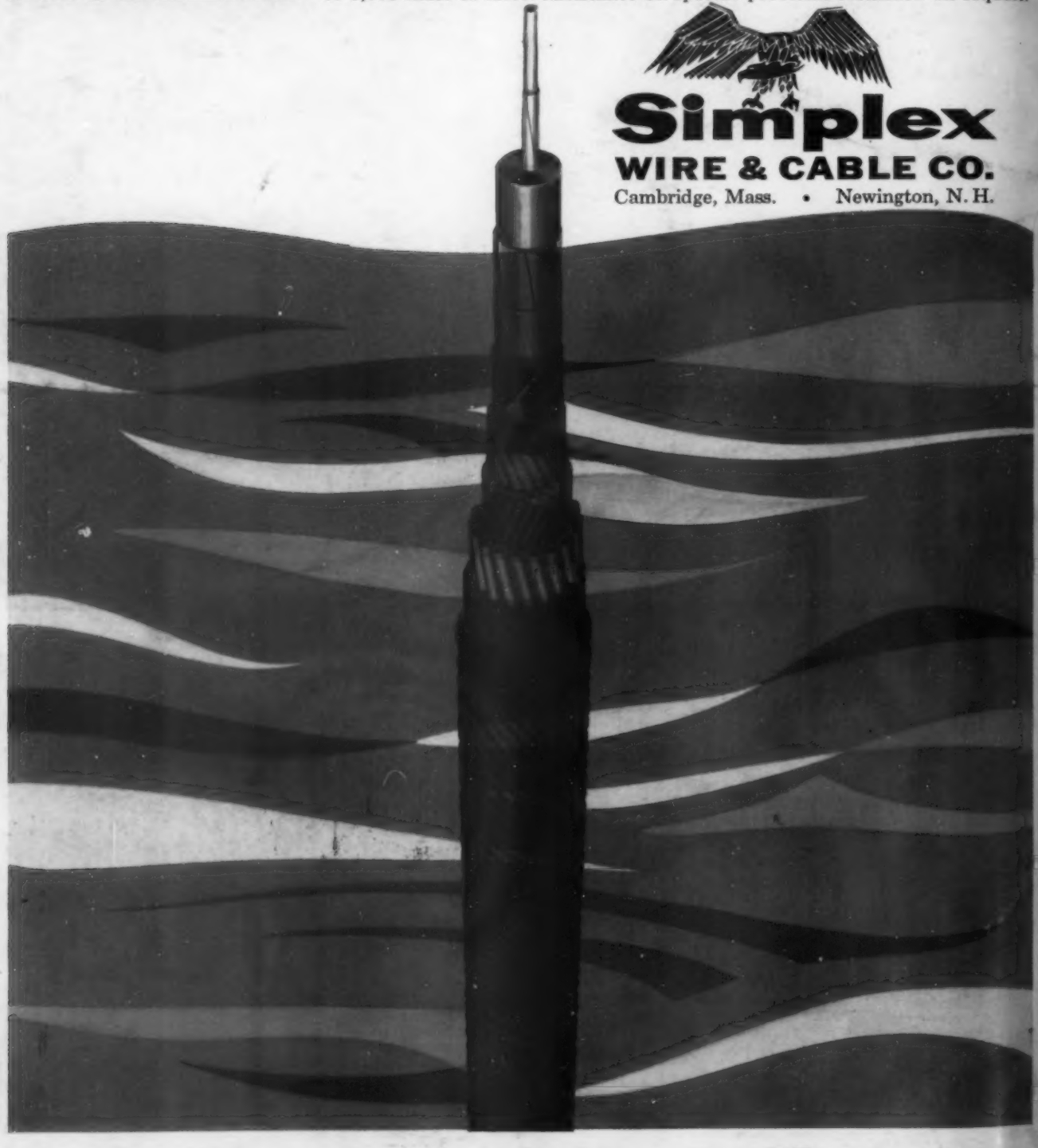
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